**The Dissertation Committee for Anushka Vasudeva Pai Certifies that this is the approved version of the following dissertation:**

# Reducing Anxiety Sensitivity: Effects of Anxiety Education and Interoceptive Exposure with $CO_2$

**Committee:**

Michael Telch, Supervisor

John Bartholomew

Christopher Beevers

John Hixon

Charles Holahan

# Reducing Anxiety Sensitivity: Effects of Anxiety Education and Interoceptive Exposure with $CO_2$

**by**

**Anushka Vasudeva Pai, B.A., M.A.**

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# Reducing Anxiety Sensitivity: Effects of Anxiety Education and Interoceptive Exposure with $CO_2$

Anushka Vasudeva Pai, Ph.D.

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Supervisor: Michael J. Telch

Abstract: Anxiety sensitivity, defined as the fear of anxiety-related sensations and their consequences (Reiss & McNally, 1985), has been consistently shown to be associated with risk for anxiety psychopathology as well as other mental health problems. The primary objective of the present secondary prevention trial sought to examine strategies to reduce anxiety sensitivity among persons with elevated anxiety sensitivity by testing the singular and combined efficacy of two commonly used strategies in multi-component interventions for reducing anxiety sensitivity: (a) anxiety psychoeducation emphasizing the benign nature of stress and (b) interoceptive exposure (i.e. repeated inhalations of 35% $CO_2$ gas mixture).

To provide a stringent control for non-specific effects associated with anxiety psychoeducation and interoceptive exposure with $CO_2$, two control strategies were included in the study design: general health and nutrition education and repeated inhalations of regular room air. Utilizing a 2X2 design, participants were randomly assigned to receive an education component and intervention sessions consisting of one of two gas mixtures.

The current study did not support the relative efficacy of hypothesized active intervention strategies. Rather, all conditions led to significant reductions in anxiety sensitivity. In addition, within-condition effect sizes for conditions in the present study were comparable to effect sizes of active interventions that were efficacious in previous research.

Findings from the present study support that anxiety sensitivity is malleable following brief, cost-efficient interventions and these reductions are maintained over a one-month follow-up period. Data from the present study suggest that in the presence of stringent control conditions, hypothesized active intervention strategies provided little additional benefit.

The present study has implications for methodological considerations for future secondary prevention trials for the reduction of anxiety sensitivity. The absence of stringent control groups might lead to premature conclusions that reductions in anxiety sensitivity are due to the specific effects of active interventions. Further research is needed to elucidate specific effects of intervention strategies for the reduction of anxiety sensitivity in at risk populations in order to refine secondary prevention interventions aimed to reduce risk for psychopathology.

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# INTRODUCTION

## Chapter 1: Background

### ANXIETY SENSITIVITY

Anxiety sensitivity is defined as the "fear of anxiety-related sensations based on their harmful consequences" (Reiss and McNally, 1985) and was originally conceptualized as a trait-like dispositional variable that describes a "fear of fear." Anxiety sensitivity was first introduced in the context of expectancy theory, which proposed that fear and anxiety in a given situation developed from the interaction of dispositional sensitivities and expectations about the feared situation. The theory posits that all common fears (e.g., fear of public speaking or fear of heights) are derived from three fundamental fears: anxiety sensitivity, fear of illness/injury and death, and fear of negative social evaluation. The interaction of these fundamental fears with expectancy beliefs about the outcomes of a given situation predicts the likelihood of fear and avoidance in that situation. Therefore, the theoretical predictions of expectancy theory delineate anxiety sensitivity as a central variable in the development and expression of anxiety.

### MEASURING ANXIETY SENSITIVITY

Anxiety sensitivity was first measured by the Anxiety sensitivity index (ASI), a 16-item questionnaire assessing fears of anxiety-related sensations and beliefs about their harmful consequences (Reiss, Peterson, Gursky, & McNally, 1986). Although anxiety sensitivity was originally conceptualized as unidimensional, factor analytic studies on the original ASI suggested that anxiety sensitivity might be better conceptualized as

multidimensional (Telch, Shermis, & Lucas, 1989; see Zinbarg, Mohlman, & Hong, 1999). Of the factor analytic studies, the most common factor solution includes three factors: physical concerns, social concerns, and cognitive concerns (see Zinbarg et al., 1999). Although the hierarchical structure of anxiety sensitivity does not support the original conceptualization of anxiety sensitivity as a fundamental fear, the lower-order factors provide additional utility when examining the relationship between anxiety sensitivity and psychological outcomes.

Because of inconsistent results in factor solutions and criticisms of the small number of items comprising certain subscales, Taylor and Cox (1998b) created the ASI-revised (ASI-R): a 36-item questionnaire aimed to more comprehensively measure the lower-order factors of anxiety sensitivity. The scale was designed to measure fears of cardiovascular, respiratory, gastrointestinal, publicly observable, dissociative and neurological, and cognitive dyscontrol concerns. Factor analytic studies based on the ASI-R have not replicated the six factors that were intended in the creation of the scale and have yielded inconsistent results (Taylor & Cox., 1998a; Zvolensky et al., 2003).

The Anxiety Sensitivity Index-3 (ASI-3; Taylor et al., 2007) was developed to measure the three most widely replicated factors: physical, social, and cognitive concerns. The study resulted in an 18-item scale with a stable three-factor solution that was replicated across gender and among individuals from various countries as well as clinical and nonclinical populations. Most of the published studies examining anxiety sensitivity in adults to date have employed the original ASI scale.

The Childhood Anxiety Sensitivity Index (CASI) was developed to measure anxiety sensitivity in children and adolescents (Silverman, Fliesig, Rabian, & Peterson., 1991). It is an 18-item scale that is similar to the original ASI but modified to be more age-appropriate. Similar to the structure of anxiety sensitivity in the adult literature, there is evidence that the CASI is hierarchical in nature, however there has been debate regarding the number of factors that best represent anxiety sensitivity (Chorpita & Daleiden, 2000; Silverman, Ginsburg, & Goedhart, 1999; Van Widenfelt, Siebelink, Goedhart, & Teffers, 2002).

Although the expectancy theory assumed a dimensional latent structure for anxiety sensitivity, additional empirical research suggests that the latent structure of anxiety might be taxonic (i.e. discrete latent classes). Studies using various versions of the anxiety sensitivity index have confirmed the taxonicity of anxiety sensitivity across gender and age group (Bernstein, Zvolensky, Feldner, Lewis, &Leen-Feldner, 2005; Schmidt, Buckner, & Keough, 2007). In addition, a cross-cultural supported a taxonic structure of anxiety sensitivity among samples from France, Mexico, Spain, the Netherlands and the US and Canada (Bernstein et al., 2006).

Additional studies have shown that a taxonic measurement of anxiety sensitivity demonstrates incremental validity in predicting clinically-relevant outcomes, such as panic symptoms, PTSD symptoms, and fear response to biological challenges (Richey, Schmidt, Hoffman, & Timpano, 2010). In addition to the utility of anxiety sensitivity taxons, research suggests that within-taxon variability provides additional utility in predicting clinically relevant outcomes (Bernstein et al., 2007; Bernstein, Zvolensky,

Marshall, & Schmidt, 2009; Zvolensky et al., 2007). Although most of the taxometric investigations have supported the taxonic latent class structure of anxiety sensitivity, the majority of research conducted thus far examining anxiety sensitivity has assumed a dimensional latent class structure.

## ANXIETY SENSITIVITY AND MENTAL HEALTH DISORDERS

### Anxiety Sensitivity and Anxiety Disorders

Consistent with expectancy theory, researchers have demonstrated a positive association between anxiety sensitivity and anxiety disorders. Compared with nonclinical individuals, individuals diagnosed with anxiety disorders display elevated anxiety sensitivity. In addition, prospective studies have found that anxiety sensitivity increases the likelihood of developing an anxiety disorder (Schmidt, Zvolensky, & Maner, 2006; Schmidt & Zvolensky, 2007).

Among the anxiety disorders, anxiety sensitivity is differentially elevated. Individuals with panic disorder and post-traumatic stress disorder (PTSD) display the highest levels of anxiety sensitivity, while individuals with specific phobias have not exhibited significant elevations in anxiety sensitivity as compared to the normal population (see Taylor et al., 1999). There is also evidence that the lower order factors of anxiety sensitivity are differentially elevated among populations with different anxiety disorders (Deacon & Abramowitz, 2006; McWilliams, Becker, Margraf, Clara & Vriends, 2007; Rector, Szacun-Shmizu, & Leybman, 2007).

#### *Anxiety Sensitivity and Panic Disorder*

Although the expectancy model purports that anxiety sensitivity predisposes individuals to developing various types of fears, the majority of research in the area of anxiety sensitivity and anxiety disorders has been conducted in relation to panic disorder. Patients with panic disorder have been shown to display the highest anxiety sensitivity among individuals with anxiety disorders (see Cox, Borger, Enns, & Freeman, 1999; Taylor, Koch, & McNally, 1992). Specifically, the physical concerns (Deacon & Abramowitz, 2006) and psychological concerns subscales (McWilliams, Becker, Margraf, Vriends & Clara, 2007) have been found to be most strongly associated with panic disorder status.

Additional research has shown that high anxiety sensitivity may be a premorbid risk factor for panicogenic response in the nonclinical population. For example, prospective studies have demonstrated that high anxiety sensitivity predicts the onset of spontaneous panic attacks and panic symptoms during stressful periods (Schmidt, Lerew, & Jackson, 1997, 1999) as well as over time (Maller & Reiss, 1992; Plehn & Peterson, 2002; Schmidt, Zvolensky & Maner, 2006). In contrast, Schmidt, Lerew, and Joiner (2000) found that the experience of spontaneous panic attacks during a stressful period adversely affected anxiety sensitivity, suggesting that distress might affect anxiety sensitivity as well.

Anxiety sensitivity is also associated with heightened fear response to fear provocation challenges. Experimental researchers interested in the phenomenon of anxiety have examined fear response to biological challenges that are intended to provoke fear and panic, such as ingestion of high doses of caffeine or inhalation of a

carbon dioxide gas mixture (Carter, Suchday, & Gore, 2001; Telch, Silverman, & Schmidt, 1996; Zvolensky et al., 1997; 1999). Physical concerns, specifically suffocation fears, have been implicated as the strongest predictors of fear response to biological challenges (Beck, & Davila, 2007; Carter et al., 2001; Eke and McNally, 1996; ; Grant, Zinbarg et al., 2001; McNally and Eke, 1996; Shipherd, Beck, & Ohtake, 2001; Tull, 2006; Zvolensky, Feldner, Eifert, & Stewart, 2001).

In addition to the research examining anxiety sensitivity as a premorbid risk factor for the development of panic and panic disorder, a small group of studies have demonstrated a pathoplastic relationship between anxiety sensitivity and panic disorder. Pathoplasty models suggest that a variable might modify the expression or course of a disorder. In laboratory experiments conducted with patients with panic disorder, anxiety sensitivity predicted fear response to voluntary hyperventilation (Carter et al., 2001; Rapee & Medoro, 1994 ) as well as inhalation of 20% $CO_2$ enriched air. (Eifert, Zvolensky, & Sorell, 1999). In addition, Schmidt and Bates (2003) found that anxiety sensitivity predicted symptom presentation among patients with panic disorder.

***Anxiety Sensitivity and PTSD***

Because patients with PTSD have displayed similar elevations in anxiety sensitivity as patients with panic disorder (Taylor et al., 1992), there has been growing interest in examining the relationship between anxiety sensitivity and PTSD.

Several studies have demonstrated a positive association between anxiety sensitivity and PTSD among trauma-exposed individuals, (Bernstein et al., 2005; Fedoroff, Taylor, Asmundson, & Koch, 2000; Hensley & Varela, 2008; Kilic, Kilic, &

Yilmaz, 2008) especially for women (Feldner, Zvolensky, Schmidt, & Smith, 2008). For example, Asmundson and Stapleton (2008) found that police officers who endorsed significant PTSD symptoms reported greater anxiety sensitivity than those who did not. Similarly, women with current PTSD exhibited higher anxiety sensitivity than women who did not develop PTSD among a sample of women with history of intimate partner violence (Lang, Kennedy, & Stein, 2002).

Additional research has shown that anxiety sensitivity is associated with traumatic stress reactions among nonclinical individuals. In a prospective study, baseline anxiety sensitivity predicted symptoms of PTSD among nonclinical individuals over an 18-month naturalistic follow-up period (Feldner et al., 2008). In addition, baseline anxiety sensitivity scores predicted subsequent PTSD symptoms among women two weeks after giving birth (Keogh, Ayers, & Francis, 2002).

Examinations of the lower order factors of anxiety sensitivity have yielded inconsistent results. Two studies suggested that the physical and psychological concerns subscales of anxiety sensitivity were significant predictors of PTSD symptoms (Lang et al., 2002; Leen-Feldner, Feldner, Reardon, Babson, & Dixon, 2008); but Collimore, McCabe, Carleton, & Asmundson (2008) found that the physical subscale was the only lower order subscale to predict symptoms of PTSD among nonclinical individuals and Feldner, Lewis, Leen-Feldner, Schnurr, & Zvolensky (2006) found that the psychological subscale was the only significant lower order predictor of PTSD symptoms among trauma-exposed young adults. Finally, Keogh et al. (2002) demonstrated that the anxiety sensitivity physical and social concerns but not psychological concerns subscales were

associated with PTSD symptoms among women who had given birth in the last two weeks. Although the specific subscales associated with PTSD remain unclear, the inconsistent results may be a function of differences among the studies in methodological designs and examined populations.

Consistent with a diathesis-stress model of PTSD, Bernstein, Zvolensky, Feldner, Lewis, and Leen-Feldner (2005) found that anxiety sensitivity interacted with trauma exposure to predict PTSD symptoms in nonclinical individuals. Furthermore, Feldner et al. (2006) demonstrated that anxiety sensitivity interacted with degree of trauma exposure such that trauma exposure was associated with PTSD symptoms in individuals with high anxiety sensitivity but not for those with low anxiety sensitivity. Finally, Lang, et al. (2002) demonstrated that traumatic experiences might subsequently amplify anxiety sensitivity; the study found that women exposed to intimate partner violence without subsequently developing PTSD displayed significantly higher anxiety sensitivity than non-exposed controls.

### *Anxiety Sensitivity and Other Anxiety Disorders*

Although expectancy theory predicts that anxiety sensitivity might predict the development of various fears, there have been few studies examining the specific relationships between anxiety sensitivity and obsessive-compulsive disorder (OCD), generalized anxiety disorder (GAD), social phobia, or specific phobias. These studies have shown that anxiety sensitivity is elevated among individuals with social phobia, GAD, and OCD but have not revealed a positive association between anxiety sensitivity and specific phobias (see Cox, Borger, & Enns 1999).

The lower-order factors of anxiety sensitivity are differentially associated with each of the anxiety disorders; as predicted, social concerns are most strongly associated with social phobia (Deacon & Abramowitz, 2006; McWilliams, Becker, Margraf, Clara & Vriends, 2007; Rector et al., 2007). Psychological concerns are strongly associated with GAD (Rector et al., 2007), and physical concerns are associated with OCD (Deacon & Abramowitz, 2006).

**Anxiety Sensitivity and Depression**

Because of the high comorbidity rates between anxiety disorders and depression, there has been a growing literature demonstrating a positive association between anxiety sensitivity and depression as well. For example, Otto, Pollack, Fava, & Rosenbaum (1995) found that depressed patients reported higher anxiety sensitivity than normal controls and that the mean of anxiety sensitivity for the depressed group was comparable to the norms published for anxiety disorders. Taylor, Koch, Woody and McLean (1996) found similar means for depressed patients, and examinations of the lower order factors indicated that the cognitive concerns subscale was most strongly related to depression. On the other hand, McWilliams, Becker, Margraf, Clara & Vriends (2007) found that the physical and social concerns subscales were elevated among individuals with depression.

In a longitudinal investigation, Cox, Enns, Freeman and Walker (2001) sought to clarify the relationship between anxiety sensitivity and depression; the study examined changes in anxiety sensitivity among individuals who were initially depressed and who recovered from major depression over a 1-year naturalistic time period. The results suggested that anxiety sensitivity improved only modestly over the time period during

which the participants were recovering from major depression. Although this does not rule out the possibility that anxiety sensitivity might have increased as a result of the disorder, it suggests that anxiety sensitivity is not a concomitant of depression. Therefore, additional research is needed in order to establish anxiety sensitivity as a pre-existing vulnerability factor for depression.

**Anxiety Sensitivity and Chronic Pain**

Cognitive behavioral models of chronic pain have proposed that fear and avoidance of pain contribute to the development and maintenance of pain (Asmundson, Norton, & Norton, 1999; Norton & Asmundson, 2003). Thus, although chronic pain is not itself considered a fear; there is relevance in examining the role of anxiety sensitivity in the area of pain.

Experimental studies utilizing pain provocation tasks provide evidence that anxiety sensitivity influences the experience of pain. Among nonclinical individuals, high anxiety sensitivity is associated with less tolerance of pain. In addition, nonclinical individuals high in anxiety sensitivity reported earlier detections of harmless electrical stimulations, suggesting that they have greater "interoceptive sensitivity" (Esteve & Camacho, 2008). Similarly, anxiety sensitivity was associated with earlier detections of pain during cold pressor task among nonclinical individuals (i.e. placing hand in a bath of cold water; Keogh & Cochrane, 2002) as well as individuals with panic disorder (Schmidt & Cook, 1999) and chronic pain (Greenberg & Burns, 2003).

Additional studies have shown that gender moderates the association between anxiety sensitivity and pain during the cold pressor tasks. Studies have suggested that

anxiety sensitivity was associated with subjective pain only in women (Keogh, Barlow, Mounce, & Bond, 2006; Keogh & Birkby, 1999) or that the association was stronger with women (Thompson, Keogh, French, & Davis, 2008). One study found that pain tolerance was negatively associated with anxiety sensitivity in men but not in women (Keogh et al., 2006).

Most research with individuals with chronic pain indicates that anxiety sensitivity is not associated with severity of pain but with the negative effects resulting from pain. For example, chronic back pain patients with high anxiety sensitivity exhibited greater negative affect, greater emotional response to pain, and greater fear of pain than patients with low anxiety sensitivity (Asmundson & Norton, 1995). Zvolensky, Goodie, McNeil, Sperry, and Sorrell (2001) found similar associations between anxiety sensitivity and fear of pain within a heterogeneous chronic pain population.

Several studies have examined cognitive behavioral models of pain and explored potential mechanisms of the association between anxiety sensitivity and pain. For example, Esteve and Camacho (2008) found that anxiety sensitivity was associated with more catastrophizing thoughts about pain during a pain provocation task; Keogh and Cochrane (2002) demonstrated that the association between anxiety sensitivity and subjective pain was mediated by negative interpretive bias. Using structural equation modeling, Asmundson and Taylor (1996) demonstrated that anxiety sensitivity was significantly associated with fear of pain after controlling for the severity of pain in patients with chronic musculoskeletal pain. In addition, they found that anxiety sensitivity predicted escape and avoidance behavior and that this association was

mediated by the fear of pain. Similarly, Norton and Asmundson (1995) found an indirect relationship of anxiety sensitivity and avoidance/escape behavior via fear of pain among individuals with recurrent headaches. Asmundson and Taylor (1996) discussed that this type of model is consistent with the theoretical predictions of expectancy theory in that common fears, such as fear of pain, can be reduced to more fundamental fears.

**Anxiety Sensitivity and Substance Use**

Because individuals with high anxiety sensitivity find anxiety-related sensations highly aversive, McNally (1996) proposed that individuals high in this trait would be motivated to use substances with anxiolytic properties as a method to avoid experiencing anxiety.

Among nonclinical populations, the association between anxiety sensitivity and substance use is not clear. Studies have demonstrated an association between anxiety sensitivity and problematic drinking (Koven, Heller, & Miller, 2005; Stewart et al. 2002) as well as anxiety sensitivity and marijuana use (Zvolensky et al., 2009), but Novak, Burgess, Clark, Zvolensky and Brown (2003) found no association between anxiety sensitivity and drinking behavior. In addition, Wagner (2001) found that anxiety sensitivity was negatively correlated with substance abuse among undergraduate students.

Research examining motives, expectancies and affect among nonclinical populations has further established anxiety sensitivity as an important variable in predicting substance use among nonclinical individuals. Anxiety sensitivity was associated with coping-related motives (Novak et al., 2003) and conformity-related motives to use alcohol (Stewart & Zeitlin, 1995) as well as marijuana (Zvolensky et al.,

2009). Anxiety sensitivity was also associated with negative reinforcement expectancies among daily smokers (Johnson et al., 2008). In addition, anxiety sensitivity was associated with drinking frequency in negatively reinforcing situations (Samoluk & Stewart, 1998). In a laboratory experiment, alcohol consumption reduced state anxiety only among individuals with anxiety sensitivity (Zack, Poulos, Aramakis, Khamba, & Macleod, 2007).

O'Connor, Farrow, & Colder (2008) demonstrated that a 3-way interaction of anxiety sensitivity, expectancies, and gender predicted drinking behavior. They found high anxiety sensitivity was associated with heavy drinking when tension reduction expectancies were high among men, and high anxiety sensitivity was associated with low levels of drinking when cognitive and behavioral impairment expectancies were high among women. They suggested that this interaction potentially explains some of the inconsistencies in findings related to the association between anxiety sensitivity and substance use in past research. Taken together, these studies suggest that individuals with high anxiety sensitivity may be motivated to use substances in anxiety-provoking situations when they have expectations that using substances will reduce distress. This is in line with McNally's prediction (1996) that anxiety sensitivity would motivate individuals to use substances with anxiolytic properties in order to tolerate anxiety-related sensations.

Cognitive-behavioral models of substance use suggest that if substance use is reinforcing, it could ultimately lead to problematic substance use. Anxiety sensitivity has been shown to be elevated among individuals diagnosed with alcohol abuse disorders (as

cited by Stewart, Zvolensky, & Eifert, 2002), and a prospective study indicated that anxiety sensitivity predicted subsequent development of alcohol abuse disorders among university students (Schmidt, Buckner & Keough, 2007). In addition, anxiety sensitivity has been shown to be associated with frequency of substance use among individuals with substance use disorders.

Research has demonstrated that anxiety sensitivity might be associated with using substances as a means to reduce negative affect among individuals with substance use as well. For example, anxiety sensitivity predicts preference for depressants among individuals with substance use disorders (DeHaas et al., 2001; 2002; Norton et al. 1997), although there was no association between anxiety sensitivity and drug of choice among veterans in an inpatient program for substance use (Forsyth, Parker, & Finlay, 2003). In addition, anxiety sensitivity was related to frequency of drinking in negative situations among women in treatment for alcohol problems, and this association was strongest when examining the physical concerns and cognitive concerns subscales (Reyno, Stewart, Brown, Wiens, & Horvath, 2006). Furthermore, Kushner, Thuras, Abrams, Stritar, and Brekke (2001) found that the relation between anxiety sensitivity and coping-related drinking motives for individuals with alcohol problems was mediated by anxiety. Contrary to predictions, however, the association between anxiety sensitivity and substance use was not stronger for individuals with comorbid anxiety disorders. (DeHaas, Calamari, Bair, & Martin 2001; DeHaas, Calamari, & Bair, 2002). Therefore, anxiety sensitivity might serve as a risk factor for motivating substance use among individuals with substance use disorders.

Anxiety sensitivity might also decrease likelihood of successfully stopping substance use. For example, anxiety sensitivity was associated with perceived barriers to quitting smoking, such as "being addicted to cigarettes" or "fear of failing to quit." In addition, the physical concerns subscale of anxiety sensitivity was related to early smoking relapse (Gonzalez, Zvolensky, Vujanovic, Marshall, & Leyro, 2008). Finally, anxiety sensitivity predicted treatment dropout among heroin users who were participating in a treatment program (Lejuez et al., 2008).

**Cost of Mental Health Disorders**

The extant literature supports theoretical predictions that anxiety sensitivity is a premorbid vulnerability factor for the development of anxiety problems, and there is also evidence that anxiety sensitivity may be an important contributor to the expression of these mental health disorders as well. Additional research has shown that anxiety sensitivity is associated with other mental health disorders including depression, chronic pain, and substance use disorders.

The mental disorders that have been found to be associated with anxiety sensitivity are highly prevalent. In the National Comorbidity Survey-replication study, anxiety disorders were the most prevalent class of Axis I disorders (28.8%), and mood (20.8%) and substance use disorders (14.6%) were also highly prevalent (Kessler, Chiu, Demler, & Walters, 2005). The lifetime prevalence of any Axis I disorder was 46.4%. With regard to chronic pain, an international World Health Organization study reported that 22% of individuals in primary care centers reported persistent pain (Gureje, Von Korff, Simon, & Gater, 1998).

In addition to the diminished quality of life for individuals suffering from these disorders, there are also considerable costs to society. Based on data from the original National Comorbidity Survey, Greenberg et al. (1999) estimated the annual cost of anxiety disorders was 42.3 billion dollars in the United States; similarly, Greenberg et al. (2003) estimated the annual cost of depression was 83.1 billion dollars based on data from the National Comorbidity Survey-revised. These estimates were based on direct treatment costs, mortality costs associated with suicide, and indirect workplace costs. For chronic pain, the costs associated with loss of productivity in the U.S. workforce alone were estimated to be $61.2 million a year based on data from 2003 (Stewart, Ricci, Chee, Morganstein, & Lipton, 2003). In a report developed for The Office of National Drug Control Policy (ONDCP), the societal cost of drug abuse in the United States was $143.4 billion in 1998. The majority of these costs were associated with productivity losses, particularly those related to incarceration, crime, illness, and premature death (Office of National Drug Control Policy, 2001). Because many of the previously mentioned estimates were based on data from the 1990s, it is likely that the current societal costs of the mental disorders are greater.

The association of anxiety sensitivity with multiple mental health problems that are prevalent and costly implies that it is a significant variable that should be targeted in prevention efforts. Research evidencing that it is a premorbid risk factor for the development of mental health disorders as well as its association with the expression of mental health disorders suggests that examining strategies to effectively reduce anxiety

sensitivity would significantly contribute to secondary and tertiary prevention efforts for multiple mental health problems.

# Chapter 2: Anxiety Sensitivity Reduction

## CLINICAL POPULATIONS

Anxiety sensitivity has been shown to be malleable with CBT (see Smits et al., 2008) as well as pharmacotherapy (Olatunji et al., 2008; Otto, Pollack, Fava, & Uccello, 1995; Simon et al., 2004) among patients with clinical disorders. In a meta-analysis, Smits et al. (2008) examined the efficacy for reducing anxiety sensitivity with CBT and found a large controlled effect size (Hedges' $g$ = 1.40) for the reduction of anxiety sensitivity among populations with clinical disorders. Of 16 studies conducted examining anxiety sensitivity reduction, most studies included patients with panic disorder; patients with social phobia, claustrophobia and tinnitus were also included.

## INTERVENTION STRATEGIES FOR NONCLINICAL POPULATIONS

Anxiety sensitivity has been shown to be modifiable following interventions conducted among nonclinical populations as well. Smits et al. (2008) found a moderate effect size for the efficacy of CBT interventions in reducing anxiety sensitivity (Hedges' g = .74) in a meta-analysis of eight studies conducted with nonclinical individuals with high anxiety sensitivity.

### CBT interventions

Prevention research has examined the efficacy of interventions targeting anxiety sensitivity reduction among nonclinical populations with high anxiety sensitivity. Although anxiety sensitivity is associated with a number of psychological conditions, it has been most studied in relation to panic disorder. Therefore, most interventions that aim to reduce anxiety sensitivity among nonclinical populations have been designed with the

prevention of panic disorder as a distal aim. As a result, the structure of these interventions has arisen from modifications of CBT protocols for the treatment of panic disorder (Barlow & Craske, 1994; Telch et al., 1993).

Early anxiety sensitivity reduction interventions were multimodal and included: psychoeducation, training in cognitive reappraisal of distorted thoughts (i.e. cognitive restructuring), training in diaphragmatic breathing, repeated exposure to external situations which are associated with anxiety and panic (i.e. in-vivo exposure), and repeated exposure to exercises which produce bodily sensations that are associated with anxiety and panic (i.e. interoceptive exposure).

Abplanalp (unpublished dissertation) conducted a large intervention study, comparing the efficacy of a 3-sesssion panic prevention training to non-specific control training among 450 university students with high anxiety sensitivity. Individuals in the panic prevention training group received psychoeducation, interoceptive exposure, and training in diaphragmatic breathing. The panic prevention training was found to decrease risk factors for panic disorder. Although the intervention did not influence likelihood of experiencing a panic attack over the 1-yr follow-up period, participants who had received panic prevention training reported less-panic related apprehension following a panic attack than those who had received control training and displayed a milder fear response to a carbon dioxide challenge. With regard to dispositional variables, the panic prevention group evidenced greater reduction in trait anxiety, fear of bodily sensations, and anxiety sensitivity at post-intervention and 1-yr follow-up.

Gardenswartz and Craske (2001) tested the efficacy of a one-day 5-hr panic prevention training workshop as compared to a wait-list control group on the reduction of anxiety sensitivity among individuals who displayed at least moderate anxiety sensitivity and who had experienced at least 1 panic attack in the last year. The prevention program included psychoeducation about panic and agoraphobia, breathing retraining, cognitive restructuring, interoceptive exposure training, and in-vivo exposure planning. Participants who had received the panic prevention workshop reported fewer panic-related symptoms and were less likely to have developed panic disorder at a 6-month follow-up assessment, however, there were no differences between groups in anxiety sensitivity reduction over time.

Kenardy, McCafferty, & Rosa (2003) compared the efficacy of a self-administered, internet-delivered 6-week panic prevention program to a wait-list control on reduction of anxiety sensitivity among individuals high in this trait. The intervention package included psychoeducation, relaxation training, cognitive restructuring, interoceptive exposure and relapse prevention education. Although participation in the program led to significantly greater reductions in symptoms of depression and anxiety-related cognitions, there was only a marginally significant trend for the benefit of the prevention program on the reduction of anxiety sensitivity.

Taken together, these panic prevention studies suggest that multimodal CBT packages designed after panic disorder treatment protocols result in decreased risk factors for panic, however, their effect on anxiety sensitivity was inconsistent.

**Brief CBT interventions**

Additional research in anxiety sensitivity reduction suggests that the combination of psychoeducation and interoceptive exposure might be sufficient for reducing anxiety sensitivity in the nonclinical population. Schmidt, Eggleston, Woolaway-Bickel, Vasey, Richey, & Fitzpatrick, (2007) tested the efficacy of a brief, one hour, anxiety sensitivity reduction intervention for nonclinical individuals high in this trait. The intervention consisted of a computer-delivered psychoeducation video and an introduction to interoceptive exposure; the comparison group watched a health education condition. The brief intervention resulted in a 30% reduction in anxiety sensitivity at post-intervention, a significantly greater reduction than those in the control group. In addition, those in the active intervention group displayed decreased fear responding to a 20% carbon dioxide challenge and a significantly greater reduction in anxiety sensitivity than those in the control group.

At 2-yr follow-up, there was some evidence that the intervention reduced risk for development of psychopathology. Results showed a trend for fewer psychological symptoms and fewer Axis I diagnoses for those in the intervention group. Given the low incidence of psychopathology in this nonclinical sample, there might have been low statistical power to determine group differences. With regard to anxiety sensitivity, however, the superiority of the intervention condition in reducing anxiety sensitivity was not maintained; the intervention effect on anxiety sensitivity at post-intervention was reduced to a non-significant trend at 2-year follow-up.

Feldner et al. (2008) augmented the strategy used by Schmidt et al. (2007) with the intent of reducing high anxiety sensitivity and daily smoking, two malleable risk

factors for panic disorder. They employed a similar research design as Schmidt et al. (2007) but added smoking cessation education to the intervention condition. With regard to anxiety sensitivity, individuals in the intervention condition showed greater reductions in anxiety sensitivity at post-intervention as well as 3-month follow-up; however, there were no group differences in anxiety sensitivity at 6-month follow-up.

Taken together, these studies suggest that multicomponent CBT packages might not be necessary for reducing anxiety sensitivity in the nonclinical population. From a public health perspective, these prevention programs were promising as they were easily disseminable, easily implemented, and cost-efficient.

Limitations of both studies included that the interoceptive exposure was demonstrated and planned in one session, but there was no assessment as to whether the participants adhered to these exercise after leaving the laboratory. Therefore, it is not clear whether the participants received benefits from the interoceptive exposure component, the computer-administered psychoeducation component, or their combination. Thus, additional research is needed to dismantle the efficacy of psychoeducation and interoceptive exposure on the reduction of anxiety sensitivity in the normal population.

**Psychoeducation Alone**

Psychoeducation about the nature of stress and anxiety has been highlighted as an important strategy in treating anxiety disorders. Psychoeducation is often the first implemented strategy as it provides a foundation for the rationale of subsequent treatment strategies in CBT treatments for anxiety disorders. Psychoeducation about the nature of

stress, anxiety and panic has also been included in most prevention programs targeting the reduction of anxiety sensitivity (e.g. Feldner et al., 2008; Kenardy et al., 2003; Schmidt et al., 2007).

In an anxiety sensitivity reduction study, Maltby (unpublished dissertation) examined the efficacy of psychoeducation alone and psychoeducation combined with interoceptive exposure as compared to wait-list controls on the reduction of anxiety sensitivity among participants high in this trait. Results showed that all three groups showed significant reductions in anxiety sensitivity at post-intervention and follow-up but the active interventions did not lead to greater reductions in anxiety sensitivity than the control intervention. Maltby, Mayers, Allen and Tolin (2005) discussed that the study might have been limited in its power to detect intervention effects since participants were selected for reporting high anxiety sensitivity and regression to the mean might have occurred. Thus, additional research is needed in order to examine whether psychoeducation might be an efficacious as a singular strategy for the reduction of anxiety sensitivity in the at risk population.

## Interoceptive Exposure

### *History of Interoceptive exposure*

Interoceptive exposure involves repeated exposure to somatic cues that resemble symptoms reported when individuals have anxiety or panic attacks. In Barlow's book (2001), Anxiety and its Disorders, the history of interoceptive exposure is reviewed; the authors stated that examples of interoceptive exposure strategies exist in early works within psychology but they have been misinterpreted or overlooked (White & Barlow,

2001). They described that Wolpe (1958) utilized repeated inhalation of $CO_2$ as a means of training the reciprocal inhibition of anxiety. In addition, early studies employing repeated administrations of biological agents that were widely used in panic provocation procedures (i.e. lactate infusion and carbon dioxide) demonstrated that anxiety and fear were reduced with repeated administrations among individuals with anxiety and panic. (Van den Hout, Van der Molen, Griez & Lousberg, 1987).

Based on this body of research and behavioral theories conceptualizing panic attacks as conditioned responses resulting from classical conditioning to interoceptive cues (Goldstein & Chambless, 1978), interoceptive exposure exercises have become a key component in contemporary CBT protocols for the treatment of panic disorder. (Barlow & Craske, 1994; Telch et al., 1993). As part of these protocols, participants are provided with education about interoceptive conditioning of fear response. Participants then complete an interoceptive assessment of various exercises that are intended to produce clusters of somatic sensations that are often reported during panic attacks. Examples of these exercises include: breathing through a coffee straw to produce smothering sensations, spinning to produce dizziness, and running in place to increase heart rate. Interoceptive exposures are then conducted for exercises that provoke a fear response during the initial assessment; participants are asked to repeat the exercises until fear is habituated or extinguished.

***Mechanisms of Interoceptive Exposure***

Although interoceptive exposure has been highlighted as an important intervention strategy in the treatment of panic disorder and other anxiety disorder, the

mechanisms of the efficacy of interoceptive exposure remain unknown. In a review, Stewart and Watt (2008) discussed the application of various models of fear reduction to explain the mechanisms for interoceptive exposure, however, additional research is needed to examine the validity of these various models.

Behavioral explanations for interoceptive exposure suggest that its efficacy can be explained via habituation or extinction mechanisms. The conditioning model of efficacy of interoceptive exposure is based on early models of fear and panic acquisition that proposed that fears developed from classical conditioning (Chambless & Goldstein, 1978; Pavlov, 1928). According to these models, individuals who repeatedly experience a frightening event (e.g. panic attack) in the presence of somatic sensations, such as light-headedness, might learn to fear these somatic sensations through associative learning.

Rescorla and Solomon's two-process theory (1967) further describes that these learned fears are maintained through operant conditioning. By avoiding exposure to feared conditioned stimuli, individuals would reduce their anxiety but maintain their fear to harmless somatic sensations.

Based on these behavioral models, repeated exposure to feared somatic sensations results in decreased fear response to these sensations via habituation or extinction.

***Cognitive Models of Fear Reduction***

Additional models of fear reduction after exposure describe that fear is reduced by providing correctional information that leads to changes in thought patterns (Rachman, 1990). In line with these models, interoceptive exposure would provide an opportunity to

challenge irrational cognitions related to expectancies about anxiety-related sensations (e.g. If I hyperventilate, I will faint; Watt & Stewart, 2008).

Bandura (1983) proposed that fears are experienced when individuals perceive that they do not have the ability to effectively cope with a given situation. In line with Bandura's model, interoceptive exposure would foster self-efficacy by providing the opportunity to gain behavioral mastery in situations where anxiety-related somatic sensations are experienced. As a result of gained self-efficacy, fear would be reduced.

Acceptance models have also recently been proposed for explaining fear reduction to negative emotional states (see Hayes, 2002). Emotional acceptance involves the willingness to experience and accept emotions without attempts to avoid or change them. Applying this model, interoceptive exposure can be thought of as an opportunity to learn to experience and accept anxiety and related somatic sensations.

**Exercise Interventions**

Although interoceptive exposure has been highlighted as an important variable in the reduction of anxiety sensitivity, no studies have examined interoceptive exposure as a singular strategy for the reduction of anxiety sensitivity among nonclinical populations. Aerobic exercise has been examined as an intervention strategy for individuals with high anxiety sensitivity because of its multiple psychological benefits, however, it has been suggested that aerobic exercise might operate as an interoceptive exposure in that it exposes individuals to sensations of physiological arousal (Smits et al., 2008).

Broman-Fulks, Berman, Rabian and Webster (2004) examined the effects of six 20-minute sessions of high intensity aerobic exercise as compared to low intensity

exercise on individuals with high anxiety sensitivity. Anxiety sensitivity was reduced in both groups, but individuals in the high intensity exercise group showed reductions in anxiety sensitivity more quickly. In addition, there were twice as many responders (i.e.> 1 SD change on ASI) in the high intensity group. In a second study comparing high-intensity exercise intervention to a no-exercise control, the findings indicated that the intervention led to greater reductions in all subscales of the ASI-R (Broman-Fulks & Storey, 2008). In both studies, there was evidence that a single 20-minute session of exercise led to significant reductions in anxiety sensitivity scores (Broman-Fulks et al., 2004; Broman-Fulks & Storey, 2008).

Smits et al. (2008) expanded upon the idea of utilizing aerobic exercise as an anxiety sensitivity reduction strategy by placing it in the context of a CBT model. Participants were assigned to an exercise intervention group, an exercise + cognitive restructuring intervention group, or a wait-list control group. Participants in both active conditions were given an interoceptive exposure rationale and asked to focus on their bodily sensations while completing 6 20-minute sessions of intense exercise. Results indicated that both exercise groups displayed similar reductions in anxiety sensitivity as well as symptoms of anxiety and depression over time, which were superior to the wait-list control group. In addition, mediation analyses showed that changes in anxiety and depression were mediated by reductions in anxiety sensitivity. Thus, there were no added benefits from including cognitive restructuring. In addition, there was evidence that the cognitive restructuring strategy was detrimental: although only a trend, attrition was greater in the condition that included cognitive restructuring.

Taken together, these studies have consistently shown that exercise alone is an effective strategy for reducing anxiety sensitivity among nonclinical individuals. Although the mechanisms by which exercise leads to reductions in anxiety sensitivity are not known, these findings suggest that interoceptive exposure might be efficacious as a singular strategy.

**Interoceptive Exposure with $CO_2$**

Although interoceptive exposure strategies are widely used, the mechanisms of fear reduction remain unknown. Current guidelines for interoceptive exposures suggest choosing exercises that elicit at least moderate fear and that produce bodily sensations that participants avoid or fear (Craske & Barlow, 2001; Telch et al., 1993). The reviewed anxiety sensitivity reduction studies conducted with individuals with high anxiety sensitivity employed traditional interoceptive exposure exercises used in panic disorder treatment protocols (e.g. running in place or voluntary hyperventilation, e.g. Schimdt et al., 2007; Gardenswartz & Craske, 2001) or aerobic exercise as methods of interoceptive exposure (e.g. Smits et al., 2008). Because individuals with high anxiety sensitivity in the normal population might not display as elevated anxiety sensitivity as individuals with panic disorder, they might not demonstrate as much sensitivity to a variety of interoceptive cues. As initial fear activation is central to the utility of interoceptive exposure exercises, the intensity of somatic sensations produced by traditional interoceptive exposure exercises and aerobic exercise may not be sufficient to activate fear in nonclinical individuals with high anxiety sensitivity. Therefore, the interoceptive

exposure exercises that were designed for panic disorder treatment might not be as relevant to this at risk population.

In panic provocation studies, inhalation of carbon dioxide/oxygen gas mixtures has been shown to consistently elicit fear and panic in individuals with high anxiety sensitivity (Harrington, Schmidt & Telch; 1996; Zvolensky et al., 1997, 1999). The inhalation of carbon dioxide produces multiple physiological sensations that are often reported during anxiety and panic attacks including chest tightness, feelings of breathlessness, light-headedness, and derealization; therefore, using carbon dioxide as an interoceptive exposure exercise may have a greater likelihood of activating fear and of resembling physiological sensations that are experienced during high anxiety sensitivity. Thus, administering repeated inhalations of carbon dioxide gas mixture may serve as a more effective interoceptive exposure strategy for individuals with high anxiety sensitivity.

***Interoceptive exposure with $CO_2$ for Panic Patients***

A small number of studies have tested the efficacy of repeated inhalations of $CO_2$ as a singular intervention strategy for the treatment of panic disorder (Griez and Van den Hout, 1986; Van den Hout, Van der Molen, Griez, & Lousberg, 1987). In a cross-over study, Griez et al. (1986) compared the efficacy of interoceptive exposure using $CO_2$ to propanolol (Beta-blocker) among 14 patients with panic disorder. Both interventions were administered over a 2-week period, with the $CO_2$ intervention consisting of 6 90-minute sessions. The $CO_2$ intervention resulted in a significant reduction in number of panic attacks (50%), while the 38% reduction after the treatment with propanolol did not

reach statistical significance. The $CO_2$ intervention also resulted in greater reductions in fear of interoceptive sensations. In addition, most patients maintained the benefits from the $CO_2$/propanolol intervention at the 6-month follow-up.

In a case study, Beck, Shipherd, and Zebb (1997) examined the influence of interoceptive exposure with 35% C02 on 17 patients with panic disorder. All participants completed 6 sessions consisting of 12 inhalation trials. They found that individuals displayed one of two fear response patterns within-sessions: habituation (participant's slope ≤ .50) or nonhabituation (participant's slope ≤ .50); these patterns were also found in a previous study (Beck & Shipherd, 1997). Although both patterns of response resulted in reduced panic, panic-related fears, and general anxiety, the change in symptoms appeared to occur faster among habituators. With regard to anxiety sensitivity, two patterns emerged as well. Nonhabituators showed an increase in anxiety sensitivity at post-intervention, and then a decrease at follow-up; habituators showed significant reductions in anxiety sensitivity, and these were maintained at one-month follow-up. Therefore, results of this study suggest that interoceptive exposure with repeated inhalations of $CO_2$ is a beneficial treatment for panic disorder but the effect of this singular strategy on reduction of anxiety sensitivity depends on fear response patterns to the interoceptive exposure exercise.

***Repeated Inhalations of $CO_2$ with Nonclinical Participants***

Repeated inhalations of $CO_2$ has not been tested in prevention studies aiming to reduce anxiety sensitivity among nonclinical individuals, however, two studies have administered repeated inhalations of carbon dioxide as a method of examining patterns of

fear responding among nonclinical populations. Beck, Shipherd, and Read (1999) exposed individuals with high anxiety to 12 trials of 35% $CO_2$/65% $O_2$ gas inhalations. Participants varied in their individual patterns of fear responding over time, with 37% of individuals demonstrating habituation, 47% demonstrating sensitization, and 16% remaining stable. In a replication utilizing a 20% $CO_2$/80% $O_2$ gas inhalations, a greater proportion of individuals displayed habituation, with 67% of participants classified as habituators and 33% classified as nonhabituators (Beck & Wolf, 2001).

The primary aim of the previous studies was to examine fear responding to repeated presentation of $CO_2$. The studies suggest different individual patterns of fear responding over time, with 37%-67% of individuals demonstrating within-session habituation. Yet, no studies have examined the effects of repeated inhalations of $CO_2$ on the reduction of anxiety sensitivity in the at risk population.

## Chapter 3: Present Study

The primary aim of the present randomized secondary prevention trial was to enhance knowledge on methods for reducing anxiety sensitivity among persons who display elevations on this dispositional variable that has been consistently shown to be associated with anxiety disorders as well as other mental health problems. This secondary prevention trial tested the singular and combined efficacy of two commonly used strategies in multi-component interventions for reducing anxiety sensitivity: (a) anxiety psychoeducation emphasizing the benign nature of stress and (b) interoceptive exposure (i.e. repeated inhalations of 35% $CO_2$ gas mixture).

All participants received two components of intervention: education and repeated inhalations of a gas mixture. To provide a stringent control for non-specific effects associated with anxiety psychoeducation (A_Ed) and interoceptive exposure with $CO_2$ (CO2), two control strategies were included in the study design: general health and nutrition education (H_Ed) and repeated inhalations of regular room air (AIR). Participants were not aware of the contents of the gas mixture they received.

Participants were matched on baseline anxiety sensitivity and community status. Utilizing a 2x2 design, participants were randomly assigned to one of four conditions: anxiety psychoeducation + carbon dioxide exposure (A_Ed + CO2), health education + carbon dioxide exposure (H_Ed + CO2), anxiety psychoeducation + breathing air (A_Ed + AIR), and health education + breathing air (H_Ed+AIR). Therefore, the present study allowed for the dismantling of two commonly combined intervention strategies: interoceptive exposure and psychoeducation.

The proposed hypotheses are below:

1. Each of the active conditions (A_Ed + CO2, H_Ed+CO2, A_Ed+AIR) will lead to greater reductions in anxiety sensitivity as compared to the double placebo group (H_Ed+AIR) , with the combination of psychoeducation and interoceptive exposure strategies (A_Ed + CO2) yielding the greatest reduction in anxiety sensitivity. Although the combination group will consistently yield the greatest reductions in anxiety sensitivity, the difference between the conditions including only one active strategy (A_Ed+AIR, H_Ed + CO2) will depend on the specific domain of anxiety sensitivity. This prediction is based on the conceptual match between the intervention strategy and the outcome.
    a. Participants in the A_Ed+AIR and H_Ed + CO2 conditions will display similar reductions on the ASI-3 full scale.
    b. For ASI -physical concerns subscale and fear of bodily sensations, the H_Ed + CO2 condition will yield greater reductions than the A_Ed + AIR condition.
    c. For ASI-cognitive concerns subscale, the A_Ed + AIR will outperform the H_Ed + CO2.
    d. Participants in the H_Ed + CO2 will exhibit less fear in response to behavioral challenges as compared to individuals in the A_Ed + AIR condition.
2. Reductions in anxiety sensitivity will be maintained over the one-month follow-up period for all active conditions (A_Ed + CO2, H_Ed+CO2, A_Ed+AIR).

3. Higher baseline anxiety sensitivity, community status, and diagnostic status will moderate reductions in anxiety sensitivity.
4. Changes in emotional acceptance and distress tolerance will mediate the effect of experimental condition on reduction of anxiety sensitivity.
5. Both conditions that include interoceptive exposure with carbon dioxide (H_Ed + CO2, A_Ed + CO2) will demonstrate within-session and between-session habituation of fear response to inhalation of CO2; the group that receives both active intervention strategies (A_Ed + CO2) will show greater within-session and between-session habituation.

# METHOD

## PARTICIPANTS

Participants (n=102) were recruited from the general Austin community via flyers and from the University of Texas Department of Psychology undergraduate research pool. Students enrolled in introductory psychology or introduction to clinical psychology received experimental credit for their participation. Participants ranged in age from 18 to 49 (M=19.58, SD=3.59), 77% were female, and 41% met for a current anxiety or mood disorder. The ethnic makeup was diverse: 51% Caucasian, 30% Hispanic, 18% Asian American, 1% African American, and 0% other. There were no differences between conditions based on gender, age, ethnicity, or diagnostic status.

The screening for the study eligibility consisted of two parts. Participants completed the anxiety sensitivity index (ASI-3), the medical history questionnaire (MHQ), and a demographics questionnaire in a pre-screening survey via the Internet. Individuals 18 and older who met inclusion criteria based on the ASI-3 (i.e., ASI > 1 SD above the mean) and who did not report medical contraindications for the inhalation of a carbon dioxide gas mixture were invited to the laboratory to participate in the present study.

At the face-to-face screening assessment, two additional eligibility requirements were imposed. In order to meet eligibility criteria, participants were required to report marked anxiety sensitivity (i.e. ASI-3> 1 SD above nonclinical mean) according to the ASI-3 at this second pre-intervention time point. In addition, participants were required to demonstrate at least mild somatic sensitivity, as indicated by a fear response of greater or

equal to 30 on a scale of 0-100 to a 2-min voluntary hyperventilation challenge. These additional inclusion criteria were imposed to ensure that study participants exhibited heightened anxiety sensitivity that was stable across time as well as across assessment modalities.

Exclusion criteria included: (a) history of medical conditions that could be aggravated by inhalation of $CO_2$ including: cardiovascular disorders (e.g., cardiac arrhythmia, cardiac failure), respiratory disorders (e.g., asthma, lung fibrosis), high blood pressure, epilepsy, stroke or seizures; (b) change in dosage of psychotropic medication during the past two weeks, (d) pregnant or lactating.

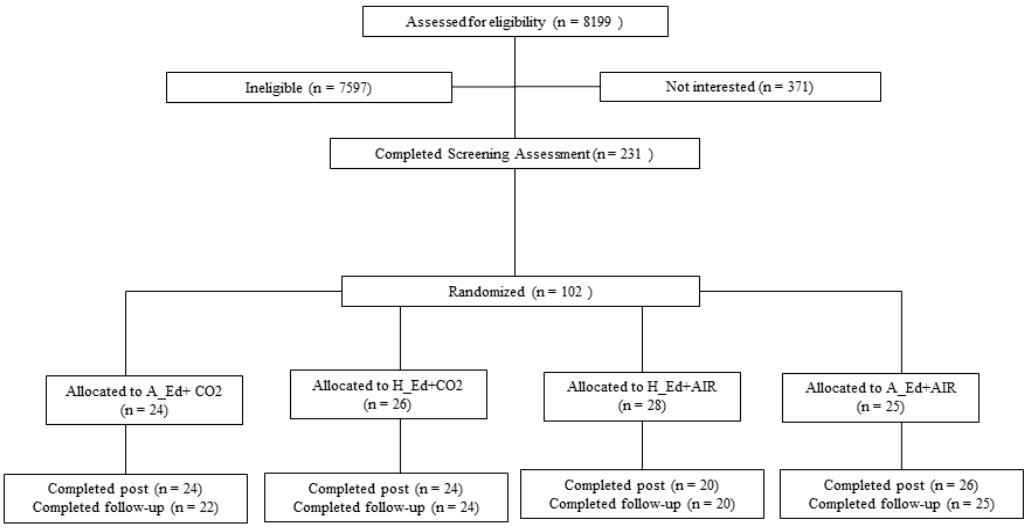


*Figure 1. Participant Flow*

## EXPERIMENTAL DESIGN

The experimental design was a 2x2 randomized intervention study with four experimental conditions. Participants were matched on pre-intervention anxiety sensitivity and community status. Using stratified randomization, participants were randomly assigned to receive a combination of psychoeducation and exposure in one of four intervention conditions: (a) anxiety psychoeducation + CO2 interoceptive exposure (A_Ed+CO2); (b) anxiety psychoeducation + breathing air exposure (A_Ed + AIR); (c) health psychoeducation + CO2 interoceptive exposure (H_Ed + CO2); (d) health psychoeducation + breathing air exposure (H_Ed+AIR). The interventions were matched on duration of psychoeducation and exposure.

## APPARATUS

There were two 212 cubic foot cylinder tanks provided by Praxair Distribution, Inc. One tank contained 35% carbon dioxide/65% oxygen medical grade compressed air (MM OXCD35-K) and the other tank contained medical grade compressed breathing air (AI M-K). Both tanks were covered with white butcher paper so they appeared identical. The gas masks (SAL 8130) were connected to the tanks through gas control regulators (WES M1-346-PG).

## MEASURES

### Demographic Questionnaire

The demographic questionnaire is an author constructed questionnaire which asks individuals about age, gender, and ethnicity.

## Medical History Questionnaire

The Medical History Questionnaire (MHQ) is an author constructed 10-item medical history questionnaire designed to identify participants with medical contraindications to inhalation of $CO_2$.

## Anxiety Sensitivity Measures

### *Anxiety Sensitivity Index-3*

The Anxiety Sensitivity Index-3 (ASI-3; Taylor et al., 2007) is an 18-item scale measuring anxiety sensitivity. Items such as 'It scares me when my heart beats rapidly' and 'When I cannot keep my mind on a task, I worry that I might be going crazy' are rated on a 5-point ('very little' to 'very much') scale. Using many items from previous versions of the Anxiety Sensitivity Index, the scale was designed to assess three factors: physical concerns, cognitive concerns, and social concerns. Confirmatory factor analyses of six replication samples, including clinical and nonclinical samples from different countries, supported the 3-factor solution. The ASI-3 displayed good reliability and validity, and there was evidence of improved psychometric properties over the original ASI (Taylor et al., 2007).

### *Body Sensations Questionnaire*

The Body Sensations Questionnaire (Chambless et al., 1984) is a 17-item measure of fears associated with physical symptoms of arousal commonly experienced during anxiety (e.g. heart palpitations, dizziness, numbness in arms or legs). Each item is rated on a 5-point Likert scale from 1 (not at all) to 5 (extremely). The scale demonstrated high

internal consistency (cronbach's alpha = .87; Schmidt & Telch, 1994) and adequate test-retest reliability (Chambless et al., 1984).

### *Behavioral challenges*

For behavioral measures of anxiety sensitivity, participants engaged in behavioral challenges intended to induce somatic reactions that resemble those that are commonly reported during anxiety/panic episodes. These tasks include: a single vital capacity inhalation of 35% carbon dioxide/65% oxygen gas, voluntary hyperventilation (up to 2 min), breathing through a coffee straw (up to 2 min), and spinning in a chair (up to 15 sec). The carbon dioxide challenge has been extensively used in panic provocation studies. The voluntary hyperventilation, straw-breathing, and spinning challenges have been widely used in panic treatment protocols.

With each behavioral challenge, participants' anticipatory anxiety before each exposure trial and fear response following each trial was measured using a Subjective Units of Distress Scale (0-100 Likert Scale). This is a common method of assessing subjective fear and anxiety in anxiety studies. In addition, participants' experience of physical and cognitive symptoms of anxiety will be recorded. These additional questions are modifications of items from the Acute Panic Inventory (API; Leibowitz, Gorman, Fyer, Dillon, & Klein, 1984).

## Other Measures of Psychopathology

### *State-Trait Anxiety Inventory- Trait subscale*

The State Trait Anxiety Inventory-Trait (STAI-T) subscale measures trait anxiety (Spielberger, Gorsuch, & Lushene, 1970). It is composed of 20 items that are scored on a

four-point Likert scale ranging from Not At All (1) to Very Much So (4). Examples of items include 'I feel nervous and restless,' and 'I have disturbing thoughts.' The scale has demonstrated good internal consistency (α=.92) and test-retest reliability (*r*=.86; Spielberger et al., 1983). Because previous anxiety sensitivity reduction studies demonstrated improvements in trait anxiety (Smits et al., 2008; Abplanalp, unpublished dissertation), it is included as an additional outcome measure.

***Beck Depression Inventory-II***

The Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) is a 21-item self-report measure designed to assess symptoms of major depression (e.g. sadness, loss of pleasure, loss of energy). The BDI-II possesses good internal consistency (α=.92; Beck et al., 1996) and distinguishes well between those with and without a diagnosis of major depression (Arnau, Meagher, Norris, & Bramson, 2001). The BDI-II is the second version of the measure, with changes designed to match criteria of major depressive disorders (MDD) in the DSM-IV.

***Brief-Fear of Negative Evaluation Scale***

The Brief-Fear of Negative Evaluation Scale (BFNE; Leary, 1983) is a 12-item scale that uses a 5-point Likert scale to measure fear of negative evaluation ranging from 0 (not at all characteristic of me) to 4 (extremely characteristic of me). Examples of items include: "I am afraid that others will not approve of me," and "I am afraid that people will find fault with me." Confirmatory factor analysis supported a two-factor solution corresponding to positive and reverse scored items. Internal consistency was good for the

full scale (a = .80) and acceptable for the positive scored factor (a= .94) and reverse scored factor (a= .73) (Duke, Krishnan, Faith & Storch, 2006).

## Measures of fear response to exposure

### *Interoceptive Exposure Process Measure*

Participants' anticipatory anxiety before each exposure trial and subjective fear response following each trial will be measures using a Subjective Units of Distress Scale (0-100 Likert Scale). This is a common method of assessing subjective fear and anxiety in anxiety studies. In addition, physical reactions to the exposure trials will be assessed using items modified from the Acute Panic Inventory (API).

### *Acute Panic Inventory*

The Acute Panic Inventory (API; Liebowitz, Gorman, Fyer, Dillon, & Klein, 1984) is a widely used self-report instrument for assessing physical and affective reactions to biological challenges. Using a 0 (none) to 3 (extreme) Likert-scale, participants rate 29 potential panic-related symptoms on severity. A Likert-scale ranging from 0 (not disturbed at all) to 100 (the worst imaginable experience) measures peak fear. The API also includes a "Yes" or "No" response question to assess the occurrence of subjective panic in response to the challenge.

## Diagnostic Status

### *The Composite International Diagnostic Interview*

The CIDI (CIDI; World Health Organization, 1997) is a brief structured interview that assesses symptoms and presence of mental health disorders derived from DSM-IV diagnostic criteria. The CIDI is a widely used for interview for diagnosis of psychiatric

disorders, and has demonstrated good sensitivity and specificity (Peters & Andrews, 1995), excellent inter-rater reliability, adequate test-retest reliability, and good validity (Andrews & Peters, 1998).

## Putative Mediators

### *Acceptance and Action Questionnaire*

The Acceptance and Action Questionnaire (AAQ; Hayes et al., 2004) measures experiential avoidance and emotional acceptance. The scale is a 9-item instrument in which statements are rated on a 1 (never true) to 9 (always true) Likert scale, with higher scores reflecting greater experiential avoidance. The AAQ-R showed adequate internal consistency ($\alpha = .70$) and test-retest reliability for the 16-item version was .64. (Hayes et al., 2004).

### *Distress Tolerance Inventory*

The Distress Tolerance Inventory (DTI; Telch & Cougle, in prep) is a 10-item scale assessing tolerance for physical or emotional distress. Statements are rated on a 1 (strongly agree) to 6 (strongly disagree) scale. Statements include 'I can usually handle feelings of emotional upset quite well' and 'I'll take fairly extreme measures to stop physical discomfort or pain.' Factor analysis revealed that the ten items fit neatly into two five-item physical and emotional distress tolerance subscales. The internal consistency was .86 for the total scale, and .87 and .85 for the emotional distress tolerance and physical distress tolerance subscales, respectively. The scale also displayed good test-retest reliability (overall: $r$=.85, p<.0001; physical: $r$=.84, and emotional: $r$=.85). An

initial validation study found the DTI to significantly predict tolerance of and distraction from film-clips inducing sadness, anger, disgust, and fear (Telch & Cougle, in prep).

## Manipulation and Credibility Check

### *Credibility/Expectancy Questionnaire*

Credibility and expectancy of the interventions will be assessed using a modified version of the Credibility/Expectancy Questionnaire (CEQ), which is a 6-item scale in which items are rated on a 0 (not at all) to 10 (extremely) Likert-type scale. Examples of questions include: ‘‘At this point, how logical does the intervention offered to you seem?’’ and ‘‘How much improvement in your anxiety sensitivity do think will occur?’’. The CEQ has demonstrated high internal consistency and test-retest reliability (Devilly & Borkovec, 2000).

### *Manipulation Check of Full Capacity Breath*

Using a 0-100 Likert Scale, the research assistant reported their confidence that the participant inhaled a full vital capacity breath of the gas mixture after each trial.

### *Perception of Assignment*

At the end of the one-month follow-up assessment, participants were told that there were two types of gas mixtures (placebo and active). They were asked to indicate which gas they felt that they had received.

## PROCEDURE

### Prescreening Assessment

Participants completed the anxiety sensitivity index (ASI-3), the medical history questionnaire (MHQ), and a demographics questionnaire via the Internet before entering the study. Individuals 18 and older who met inclusion criteria based on the ASI-3 (i.e., ASI > 1 SD above the nonclinical mean) and who did not report medical contraindications were invited to the laboratory to participate in the present study.

### Screening Assessment

After giving informed consent, participants completed the baseline questionnaires which included measures of anxiety sensitivity (ASI-3, BSQ), fear of negative evaluation (BFNE), other psychological dispositions (STAI-T, BDI-II) and putative mediators (AAQ-9, DTI).Participants who did not report elevated anxiety sensitivity on the ASI-3 at this second time point (i.e. ASI-3 < 1 SD above the mean) were informed that they were not eligible for the intervention phase of the study.

Participants who reported elevated anxiety sensitivity based on the ASI-3 were administered the second face-to-face screening assessment: a 2-min voluntary hyperventilation challenge. Participants who reported a fear response less than 30 out of 100 to the hyperventilation challenge were informed that they were not eligible for the intervention phase of the study.

Individuals who displayed marked anxiety sensitivity at the screening assessment according to the ASI-3 and who reported at least mild fear to the voluntary hyperventilation challenge (peak fear ≥ 30) were deemed eligible for the study.

Participants were matched on pre-intervention anxiety sensitivity and community status. Using stratified randomization, participants were randomly assigned to receive a combination of psychoeducation and exposure in one of four intervention conditions: (a) anxiety psychoeducation + CO2 interoceptive exposure (A_Ed+CO2); (b) anxiety psychoeducation + breathing air exposure (A_Ed + AIR); (c) health psychoeducation + CO2 interoceptive exposure (H_Ed + CO2); (d) health psychoeducation + breathing air exposure (H_Ed + AIR).

## Intervention Session 1

### *Psychoeducation*

The first intervention session immediately followed the screening assessment. The intervention began with the psychoeducation component, which consisted of participants watching an animated powerpoint presentation on a computer screen (anxiety psychoeducation or health psychoeducation). These materials have been used in a previous studies (Feldner et al., 2008; Schmidt et al., 2007) and are of equal length.

The anxiety psychoeducation presentation describes the nature of stress and the effects of stress on the body. The presentation emphasizes the benign nature of stress, providing corrective information regarding the relationship between stress and physiological arousal. Finally, information about the interoceptive conditioning of fear is given. The control presentation focuses on health and nutrition, and the presentation does not address fear or stress. Individuals in the A_Ed + AIR and A_Ed+CO2 conditions watched the anxiety psychoeducation presentation while individuals in the H_Ed +CO2 and H_Ed+AIR conditions watched the health education video.

### *Inhalation Training*

The second step of the first intervention session involved training the participants in the gas inhalation procedure. The training procedure was identical for all participants. The research assistants describe the rationale for interoceptive exposure, emphasizing that people habituate to uncomfortable sensations with repeated exposure. The participants viewed a 2-min video clip on the computer describing the inhalation procedure. The video explained that they would be inhaling a gas mixture that is not harmful but may elicit some uncomfortable sensations. The procedures for inhaling the gas mixture were then outlined. First, participants were instructed to exhale all of the air from their lungs and place the gas mask over their mouth and nose to ensure that only the gas mixture was being inhaled. Second, the video emphasized that the participants should take a full, deep breath of the gas mixture before removing the mask from their face. Third, the participants were instructed to hold the gas mixture in their lungs for five additional seconds before exhaling. Finally, participants were shown a demonstration of an individual undergoing a carbon dioxide challenge.

Participants were then led to a chair next to the two gas tanks to practice the inhalation procedure without receiving any gas mixture. The research assistant handed the gas mask to the participant. The participant practiced the inhalation procedure, and the research assistant provided corrective feedback to ensure a full vital capacity inhalation. Participants then completed the modified CEQ, reporting the credibility of the intervention and their expectancy of intervention efficacy.

***Repeated inhalations of gas mixture***

The inhalation component consisted of 6 trials of a single vital capacity inhalation of the training gas mixture (35% $CO_2$/65% $O_2$ or breathing air). Before each trial, the research assistant asked participants about their anticipatory anxiety with regard to the next trial. There was a 2 min inter-trial recovery period between each trial during which participants completed the intervention process measure. In addition, the research assistants completed their reports on their confidence that the participant inhaled a full vital capacity breath after each trial. At the end of the 6 trials of interoceptive exposure, participants completed the Acute Panic Inventory (API). Participants in the A_Ed + AIR and H_Ed +AIR completed the exposure with breathing air and individuals in the H_Ed+CO2 and A_Ed+CO2 completed the interoceptive exposure with the carbon dioxide gas mixture.

**Intervention Sessions 2 and 3**

The procedure for the intervention sessions 2 and 3 were identical and consisted of two parts: completion of psychological measures and exposure with repeated gas inhalations. Participants first completed the anxiety sensitivity index (ASI-3) and putative mediator measures (DTI and AAQ). Participants then completed the exposure to six trials of gas inhalations that were conducted in intervention session 1.

**Post-intervention Assessment**

The post-intervention assessment consisted of three parts: a semi-structured diagnostic interview (CIDI-auto), completion of the post-intervention battery, and participation in the behavioral challenges.

The research assistant administered the CIDI-auto to determine presence of anxiety and mood disorders and participants completed the post-intervention assessment battery (same outcome assessments given at pre-intervention). Participants then engaged in the behavioral challenges. Regardless of the gas mixture received during the intervention sessions, participants in all conditions underwent a carbon dioxide challenge. To balance expectations, participants were told that they may or may not receive the gas mixture that they received during the exposure sessions. Participants then completed the hyperventilation challenge, spinning challenge, and straw breathing challenge. Following each of the behavioral challenges, participants completed process measures.

**One-Month Follow-up Assessment**

One month after post-intervention assessment, participants completed the self-report measures and behavioral challenges that were administered as at post-intervention, however, the CIDI-auto was not readministered. In addition, participants were asked about their perception of whether they were assigned to an active or placebo gas mixture. Debriefing included a written debriefing statement, which indicated the nature and purpose of the experiment and included the contact information for the laboratory for the study of anxiety disorders. Participants were also given a referral sheet for psychological services.

# RESULTS

## PRE-INTERVENTION EQUIVALENCE

There were no pre-intervention differences between conditions on demographic or outcome measures, suggesting random assignment to condition was successful.

| Condition | ASI | BSQ | BFNE | HYP | DTSE | DTSP | AAQA | AAQW | BDI | STAI |
|---|---|---|---|---|---|---|---|---|---|---|
| A_Ed+CO2 | 37.05 (8.49) | 3.00 (.69) | 44.23 (7.24) | 53.00 (19.60) | 17.95 (4.50) | 16.27 (5.08) | 38.00 (4.54) | 24.82 (5.46) | 19.05 (8.37) | 49.09 (7.82) |
| H_Ed+CO2 | 36.15 (8.17) | 2.87 (.66) | 46.22 (6.77) | 60.70 (19.40) | 20.62 (4.15) | 17.27 (4.29) | 34.22 (5.67) | 21.48 (4.41) | 20.44 (7.77) | 53.78 (6.89) |
| A_Ed+AIR | 35.72 (7.58) | 3.14 (.53) | 45.96 (7.42) | 54.40 (17.10) | 18.64 (4.84) | 18.72 (5.55) | 36.72 (5.47) | 22.20 (6.20) | 19.48 (8.10) | 51.32 (8.83) |
| H_Ed+AIR | 36.68 (9.07) | 3.07 (.61) | 44.36 (7.45) | 58.90 (21.00) | 19.04 (5.13) | 18.93 (6.04) | 37.54 (6.21) | 22.96 (6.51) | 18.93 (10.15) | 51.12 (9.21) |
| F (3,98) | 0.12 | 0.92 | 0.53 | 0.90 | 1.43 | 1.36 | 2.38 | 1.49 | 0.17 | 1.33 |

*Table 1. Pre-intervention means and standard deviations of outcome measures by condition*

## ATTRITION

Eight participants dropped out during the intervention. Overall, there was 7.7% dropout (13.04% in A_Ed+CO2, 11.54% in H_Ed+CO2, 4.00% in A_Ed+AIR, and 3.7% in H_Ed+AIR). Two-tailed Fisher's exact test indicated there was not a significant difference between proportion of dropout based on condition ($p$=.52).

## INTEGRITY OF MANIPULATION

Independent samples t-tests were conducted to examine differences in intensity of sensations, symptoms of breathlessness, and symptoms of lightheadedness in response to the type of gas mixture. For all outcome variables, there was a significant difference based on GAS.

| | CO2 conditions | | AIR conditions | | |
|---|---|---|---|---|---|
| | | | Intensity of physical sensations | | |
| | *M* | *SD* | *M* | *SD* | *t* |
| Session 1 | 6.23 | 2.24 | 4.14 | 2.93 | -3.84*** |
| Session 2 | 3.48 | 2.47 | 2.36 | 2.49 | -2.18* |
| Session 3 | 3.02 | 2.48 | 1.58 | 1.96 | -3.14** |
| | | | Lightheadedness sensations | | |
| | *M* | *SD* | *M* | *SD* | *t* |
| Session 1 | 1.89 | 1.04 | 1.30 | 0.95 | -2.85** |
| Session 2 | 1.50 | 1.07 | 0.84 | 0.91 | -3.23** |
| Session 3 | 1.84 | 1.01 | 0.94 | 0.89 | -4.60*** |
| | | | Breathlessness sensations | | |
| | *M* | *SD* | *M* | *SD* | *t* |
| Session 1 | 2.14 | 0.90 | 1.38 | 0.97 | -3.90*** |
| Session 2 | 1.82 | 1.62 | 1.00 | 0.99 | -3.00** |
| Session 3 | 1.89 | 1.04 | 1.08 | 1.03 | -3.78*** |

*$p$<.05,**$p$<.01, ***$p$<.0001

*Table 2. Effects of gas mixture on intensity of physiological sensations during inhalation*

## OUTCOME ANALYSES

Primary outcome analyses examined the effects of type of education (EDU) and type of gas mixture (GAS) on anxiety sensitivity at post-intervention and follow-up, indexed as a decrease in self-reported anxiety sensitivity and its lower order factors as well as fear response to behavioral challenges. Analyses of each outcome variable examined: (1) within-condition reductions in outcome variables, (2) the effects of type of education and type of gas mixture on outcome variables at post-intervention and follow-up. In addition, moderator analyses were conducted to examine whether baseline anxiety sensitivity and diagnostic status moderated the effects of GAS and EDU on outcome variables. To examine specificity of anxiety psychoeducation and interoceptive exposure with CO2 strategies, similar analyses were conducted with psychological disposition variables that are related to anxiety sensitivity (i.e. trait anxiety, depression symptoms, fear of negative evaluation, fear of bodily sensations).

Within-condition analyses examined changes in each outcome variable from pre-intervention to post-intervention as well as pre-intervention to follow-up using paired *t*-tests.

Separate hierarchical linear regression analyses were conducted for all outcome measures at post-intervention assessment as well as at one-month follow-up assessment. For each outcome variable, the main effects of EDU and GAS as well as their interaction were examined after including baseline scores of the dependent variable as a covariate.

Similar hierarchical linear regression analyses were conducted to examine the effects of putative moderators (i.e. baseline anxiety sensitivity and diagnostic status) on the effects of intervention strategies on all outcome variables at post-intervention and

one-month follow-up. For each model, the 3-way interaction (EDU X GAS X moderator) was examined after controlling for baseline score of the outcome variable. The model was condensed by removing terms that were not significant in a backward stepwise fashion until only terms that were at least marginally significant ($p$ <.10) remained.

Within-condition analyses showed significant reductions from pre-intervention to post-intervention and pre-intervention to follow-up intervention in anxiety sensitivity for all conditions. In addition, there were significant reductions in other outcome variables.

There were no significant effects of EDU, GAS, or their interaction for any of the outcome variables at post-intervention or follow-up. In addition, the putative moderator variables did not influence effects of intervention strategies on any outcome variables at post-intervention or follow-up. Therefore, there were no differential effects based on intervention strategies for any of the primary outcome analyses.

| | A_Ed+CO2 | | H_Ed+CO2 | | A_Ed+AIR | | H_Ed+AIR | |
|---|---|---|---|---|---|---|---|---|
| Session 1 | 37.48 | (8.60) | 35.88 | (8.22) | 35.58 | (7.71) | 36.08 | (8.02) |
| Session 2 | 31.75 | (7.77) | 32.50 | (10.67) | 31.50 | (9.60) | 30.65 | (9.25) |
| Session 3 | 29.35 | (10.30) | 29.92 | (12.46) | 26.42 | (10.62) | 27.46 | (10.76) |
| Post | 27.80 | (8.70) | 29.29 | (12.97) | 27.04 | (11.16) | 25.65 | (11.92) |
| Follow-up | 29.00 | (10.17) | 29.09 | (12.86) | 25.66 | (13.11) | 28.27 | (11.63) |

*Table 3. Means and standard deviations for anxiety sensitivity*

| | A_Ed+CO2 | | H_Ed+CO2 | | A_Ed+AIR | | H_Ed+AIR | |
|---|---|---|---|---|---|---|---|---|
| | | | | Physical Concerns | | | | |
| Session 1 | 10.95 | (4.42) | 8.96 | (5.10) | 10.42 | (4.62) | 9.96 | (4.61) |
| Session 2 | 9.35 | (5.35) | 8.50 | (5.23) | 9.13 | (4.88) | 8.27 | (4.94) |
| Session 3 | 8.60 | (6.27) | 7.08 | (5.14) | 6.67 | (5.00) | 6.53 | (4.63) |
| Post | 8.00 | (5.78) | 6.79 | (5.57) | 7.08 | (5.19) | 5.73 | (4.46) |
| Follow-up | 7.85 | (5.83) | 7.59 | (5.94) | 7.13 | (5.30) | 7.50 | (5.20) |
| | | | | Social Concerns | | | | |
| Session 1 | 16.74 | (3.52) | 17.20 | (3.82) | 16.20 | (4.12) | 16.19 | (3.91) |
| Session 2 | 14.30 | (4.70) | 16.00 | (4.79) | 15.58 | (5.14) | 15.04 | (5.22) |
| Session 3 | 13.75 | (5.04) | 15.86 | (5.40) | 13.75 | (6.19) | 14.58 | (5.10) |
| Post | 13.75 | (5.47) | 16.04 | (5.87) | 14.33 | (6.37) | 13.92 | (5.48) |
| Follow-up | 13.85 | (4.40) | 15.09 | (5.78) | 13.17 | (6.70) | 14.46 | (5.61) |
| | | | | Cognitive Concerns | | | | |
| Session 1 | 9.79 | (5.30) | 9.71 | (4.84) | 8.95 | (5.09) | 9.92 | (4.21) |
| Session 2 | 8.10 | (5.43) | 8.00 | (4.83) | 6.79 | (4.88) | 7.35 | (5.02) |
| Session 3 | 7.00 | (4.81) | 6.96 | (5.56) | 6.00 | (5.76) | 6.35 | (5.64) |
| Post | 6.05 | (4.59) | 6.46 | (5.35) | 5.63 | (5.30) | 6.00 | (5.46) |
| Follow-up | 7.30 | (4.74) | 6.41 | (5.35) | 5.38 | (5.45) | 6.31 | (4.61) |

*Table 4. Means and standard deviations for anxiety sensitivity subscales*

| | A_Ed+CO2 (n=20) | | H_Ed+CO2 (n=24) | | A_Ed+AIR (n=24) | | H_Ed+AIR (n=26) | |
|---|---|---|---|---|---|---|---|---|
| **Hyperventilation Challenge** | | | | | | | | |
| Pre | 50.50 | (19.59) | 59.58 | (19.44) | 55.42 | (16.68) | 58.08 | (19.80) |
| Post | 35.00 | (23.73) | 40.42 | (24.40) | 34.58 | (27.34) | 38.85 | (29.84) |
| Follow-up | 30.50 | (27.04) | 33.18 | (26.07) | 22.92 | (24.93) | 32.80 | (30.62) |
| **CO2 Challenge** | | | | | | | | |
| Post | 32.50 | (27.89) | 25.83 | (21.24) | 42.92 | (31.13) | 36.15 | (32.63) |
| Follow-up | 28.00 | (22.85) | 28.64 | (21.22) | 27.92 | (27.34) | 34.80 | (30.70) |
| **Spinning Challenge** | | | | | | | | |
| Post | 21.50 | (23.68) | 12.08 | (16.41) | 17.50 | (24.18) | 24.23 | (28.59) |
| Follow-up | 19.50 | (17.91) | 25.00 | (31.12) | 11.67 | (22.20) | 19.60 | (23.71) |
| **Straw-breathing Challenge** | | | | | | | | |
| Post | 30.50 | (26.65) | 22.08 | (22.06) | 33.33 | (28.84) | 28.08 | (26.08) |
| Follow-up | 23.00 | (24.52) | 25.00 | (21.77) | 30.00 | (30.36) | 24.40 | (31.37) |

*Table 5. Means and standard deviations for fear response to behavioral challenges*

| | A_Ed+CO2 | | H_Ed+CO2 | | A_Ed+AIR | | H_Ed+AIR | |
|---|---|---|---|---|---|---|---|---|
| | | | | Trait Anxiety | | | | |
| Pre | 48.26 | (7.68) | 53.54 | (6.69) | 50.92 | (8.79) | 50.35 | (8.90) |
| Post | 45.15 | (8.17) | 51.58 | (8.45) | 49.08 | (10.05) | 48.31 | (11.11) |
| Follow-up | 46.05 | (5.91) | 51.82 | (7.18) | 49.71 | (8.12) | 49.38 | (8.61) |
| | | | | Depression Symptoms | | | | |
| Pre | 17.84 | (6.83) | 20.33 | (7.95) | 19.12 | (8.07) | 18.58 | (9.75) |
| Post | 12.55 | (8.36) | 15.46 | (9.14) | 14.79 | (8.46) | 15.65 | (10.61) |
| Follow-up | 10.65 | (6.20) | 14.45 | (10.00) | 13.71 | (8.33) | 14.56 | (11.71) |
| | | | | Fear of Negative Evaluation | | | | |
| Pre | 43.68 | (7.59) | 45.92 | (6.98) | 45.54 | (7.27) | 43.81 | (7.34) |
| Post | 42.20 | (7.45) | 44.38 | (7.13) | 42.75 | (6.62) | 41.62 | (7.85) |
| Follow-up | 41.75 | (7.48) | 44.68 | (7.13) | 42.92 | (7.12) | 42.61 | (8.30) |
| | | | | Body Sensations Questionnaire | | | | |
| Pre | 3.06 | (0.69) | 2.80 | (0.66) | 3.13 | (0.54) | 3.00 | (0.66) |
| Post | 2.85 | (0.64) | 2.42 | (0.66) | 2.55 | (0.83) | 2.50 | (0.87) |
| Follow-up | 2.53 | (0.64) | 2.34 | (0.66) | 2.45 | (0.85) | 2.54 | (0.69) |

*Table 6. Means and standard deviations for other psychological dispositions*

| | A_Ed+CO2 | | H_Ed+CO2 | | A_Ed+AIR | | H_Ed+AIR | |
|---|---|---|---|---|---|---|---|---|
| | Pre-Post | Pre-FU | Pre-Post | Pre-FU | Pre-Post | Pre-FU | Pre-Post | Pre-FU |
| Anxiety sensitivity | | | | | | | | |
| Anxiety sensitivity | 6.74*** | 5.62*** | 3.66** | 3.77** | 3.78** | 4.33*** | 5.78*** | 3.77** |
| AS physical | 3.66** | 3.92** | 2.89** | 1.69 | 3.55** | 3.17** | 5.14*** | 2.68* |
| AS cognitive | 4.13** | 3.35** | 4.32*** | 4.28*** | 3.85** | 4.13*** | 5.19*** | 5.14*** |
| AS social | 3.00** | 3.57** | 1.55 | 2.56* | 2.12* | 3.91** | 2.70* | 1.78 [a] |
| Other psychological dispositions | | | | | | | | |
| Trait anxiety | 1.66 | 0.86 | 2.63* | 2.93** | 1.80 [a] | 1.01 | 1.85 [a] | 0.70 |
| Depression | 2.90*** | 4.77*** | 4.61*** | 4.84*** | 3.53** | 4.36*** | 2.69* | 3.07** |
| Fear of bodily sensations | 5.21*** | 4.97*** | 3.08** | 4.26*** | 4.62*** | 4.93*** | 3.37** | 3.83** |
| Fear of negative evaluation | .49 | .65 | 1.95[a] | 2.48* | 3.79** | 2.97** | 2.22* | 1.06 |

[a]$p<.10$,*$p<.05$, **$p<.01$, ***$p<.0001$

*Table 7. Within-condition paired t-tests*

| | A_Ed+CO2 | | H_Ed+CO2 | | A_Ed+AIR | | H_Ed+AIR | |
|---|---|---|---|---|---|---|---|---|
| | Pre-Post | Pre-FU | Pre-Post | Pre-FU | Pre-Post | Pre-FU | Pre-Post | Pre-FU |
| Anxiety sensitivity | | | | | | | | |
| Anxiety sensitivity | 1.43 | 1.17 | 0.87 | 0.89 | 0.80 | 0.98 | 1.23 | 0.77 |
| AS physical | 0.75 | 0.74 | 0.60 | 0.36 | 0.73 | 0.65 | 1.01 | 0.53 |
| AS social | 0.82 | 0.89 | 0.37 | 0.56 | 0.49 | 0.86 | 0.56 | 0.37 |
| AS cognitive | 0.86 | 0.69 | 0.89 | 0.92 | 0.78 | 0.84 | 1.07 | 1.01 |
| Other psychological dispositions | | | | | | | | |
| Trait anxiety | 0.44 | 0.23 | 0.61 | 0.40 | 0.38 | 0.21 | 0.39 | 0.14 |
| Depression | 0.72 | 1.15 | 0.96 | 0.96 | 0.72 | 0.89 | 0.53 | 0.57 |
| Fear of negative evaluation | 0.24 | 0.24 | 0.40 | 0.29 | 0.83 | 0.61 | 0.44 | 0.22 |
| Fear of bodily sensations | 0.49 | 1.09 | 0.63 | 0.79 | 1.04 | 1.12 | 0.68 | 0.74 |

*Table 8. Within-condition Cohen's d effect sizes for self-report outcome measures*

**Clinically Significant Change**

In accordance with the guidelines put forth by Jacobsen and Truax (1992), participants were classified as exhibiting clinically significant change if they demonstrated reliable change in reduction in anxiety sensitivity and if their anxiety sensitivity scores at the end point were less than the midpoint between the sample mean (the "at risk" group mean) and the normative mean. Reliable change is defined as 1.96 X SD at baseline X SQRT(2) X SQRT (1-reliability). The midpoint between the "at risk" sample and the normative sample was determined by calculating SD (normative data) X

*M* (“at risk” sample) + SD (“at risk” sample) + *M* (normative data)/ SD (normative data) + SD (“at risk” sample).

Separate binary logistic regression analyses were conducted to examine the effects of EDU, GAS, and their interaction on clinically significant change at post-intervention and follow-up. Results were not significant for the effects of EDU, GAS, or their interaction on clinically significant change at post-intervention. Analyses revealed a significant GAS effect for clinically significant change at one-month follow-up (Wald $X^2(1) = 4.36$, $p = .04$), suggesting that participants who received AIR demonstrated greater percentage of clinically significant change at follow-up.

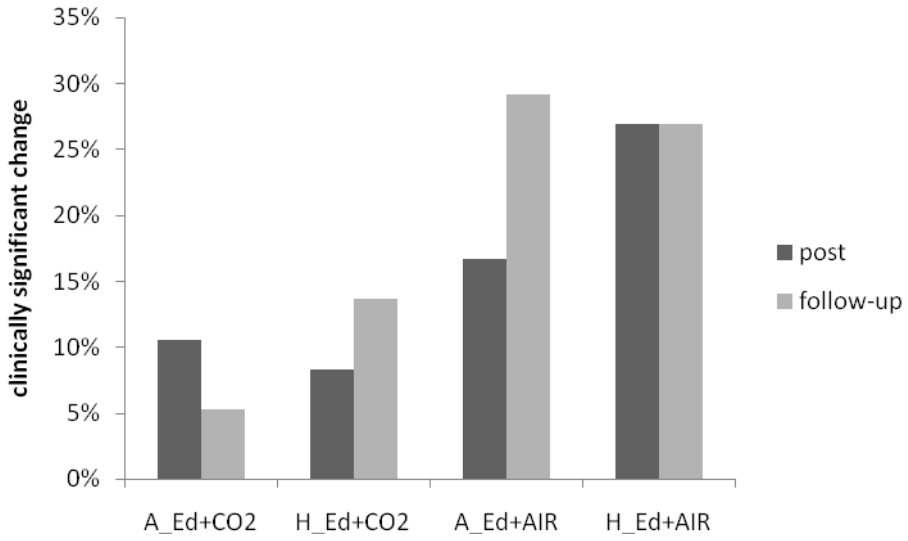


*Figure 2. Percentage of participants displaying clinically significant change by condition*

## PROCESS ANALYSES

### Anxiety Sensitivity Process Analyses

Process analyses of each outcome variable examined the effects of EDU and GAS on change in anxiety sensitivity as well as its lower order subscales over time. For each outcome variable, separate 2-level HLM models examined changes in anxiety sensitivity and its three subscales over four time points (session 2, session 3, post-intervention, follow-up) as a function of EDU, GAS and the interaction of these two intervention strategies. Anxiety sensitivity at session 1 was included as a covariate.

The level-1 model estimated within-subject change in outcomes as a function of time. $Time^2$ was included as an additional level-1 variable to examine quadratic patterns of change. In the level-1 model, the rate of change was indicated by the slopes of Time and $Time^2$; the outcome variable at session 2 was represented by the intercept. The level-2 model examined whether the variation of regression coefficients for the level-1 predictors were determined by the interaction of EDU and GAS, after controlling for the baseline level of the outcome variable.

The Akaike information criterion (AIC) was used to determine which random effects to include in the final HLM model. After including the significant random effects, the fixed effects of each HLM model were examined. The full model included the 3-way interaction of EDU X GAS X $Time^2$ and EDU X GAS X Time as well as their lower order terms. The model was condensed by removing non-significant terms in a backward stepwise fashion until only terms that were at least marginally significant remained.

Similar 2-level HLM analyses were conducted to examine whether baseline anxiety sensitivity and diagnostic status moderated the effects of EDU, GAS, or their interaction on changes in outcome variables over time. For each variable, the full model included the 4-way interactions of Moderator X EDU X GAS X Time$^2$ and Moderator X EDU X GAS X Time as well as their lower order terms on reduction in anxiety sensitivity and its three subscales.

***Intervention Strategies on Anxiety Sensitivity Process***

The final models for the full scale of anxiety sensitivity as well as the social and cognitive subscales did not include significant effects of EDU, GAS, or their interaction. In contrast, the final model for the physical subscale included a marginally significant GAS X Time interaction ($b$= 1.35, $t(273) = 1.91$, $p = .06$) as well as a significant GAS X Time$^2$ effect ($b$= -0.46, $t(273) = -2.03$, $p = .04$).

Although both CO2 conditions and AIR conditions showed reductions in AS physical concerns over the intervention sessions, the CO2 conditions maintained reductions over the one-month follow-up period whereas the AIR conditions did not.

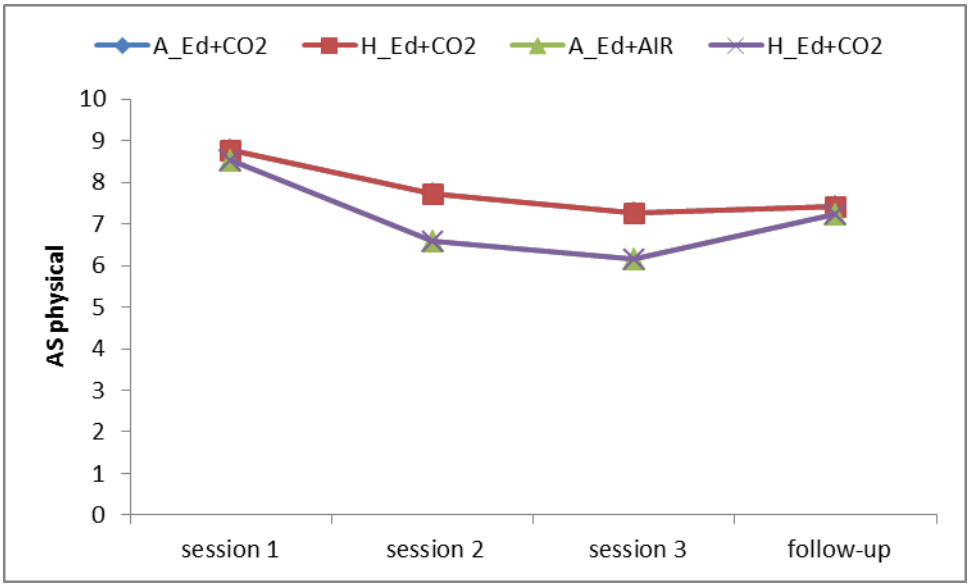


*Figure 3. Type of gas mixture on reduction in AS physical subscale*

***Moderators for Anxiety Sensitivity Process***

*Baseline Anxiety Sensitivity Moderates Anxiety Sensitivity Process*

For the full scale of anxiety sensitivity, there was a marginally significant Baseline AS X GAS X EDU X Time interaction (b= .70, t(260) = 1.82, p = .07) and a significant Baseline S X GAS X EDU X Time$^2$ interaction (*b*= -0.25, *t*(261) = -2.11, *p* = .04).

When baseline anxiety sensitivity was severe, the H_Ed conditions continued to decrease over time points whereas the A_Ed conditions showed curvilinear changes. The A_Ed +AIR condition decreased in anxiety sensitivity over the intervention sessions, but did not fully maintain its reductions over the one-month follow-up period. The condition

that received both active intervention strategies (A_Ed + CO2) exhibited the fastest decrease in anxiety sensitivity (by session 1) and maintained these reductions over time.

When baseline anxiety sensitivity was at the eligibility cutoff, all active conditions (i.e. all conditions that included either CO2 training or anxiety psychoeducation) decreased in anxiety sensitivity over intervention sessions and maintained these reductions over the follow-up period. Although the double placebo condition (H_Ed+AIR) also demonstrated reductions in anxiety sensitivity over the intervention sessions, it did not fully maintain the reduction over the follow-up period.

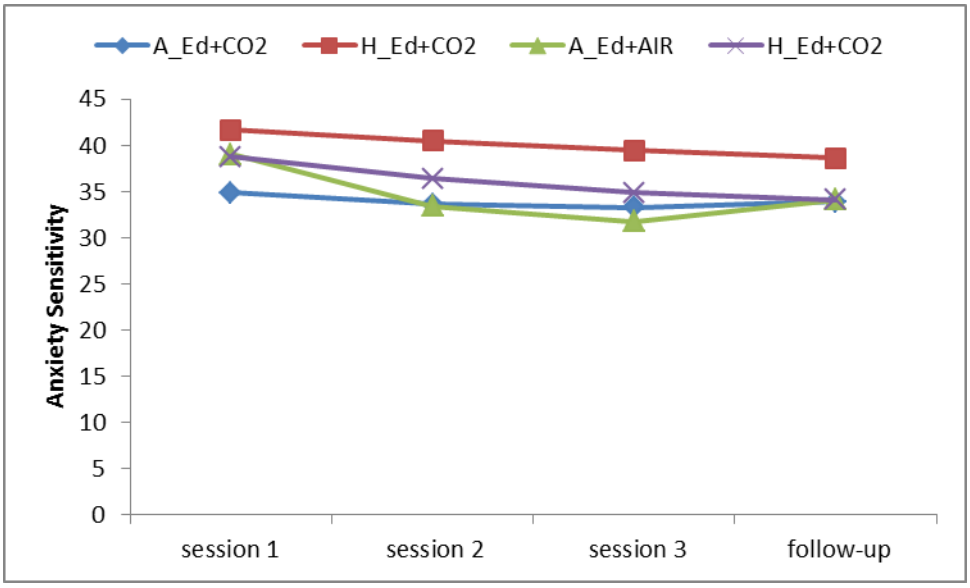


*Figure 4. Reduction in anxiety sensitivity when baseline anxiety sensitivity is severe*

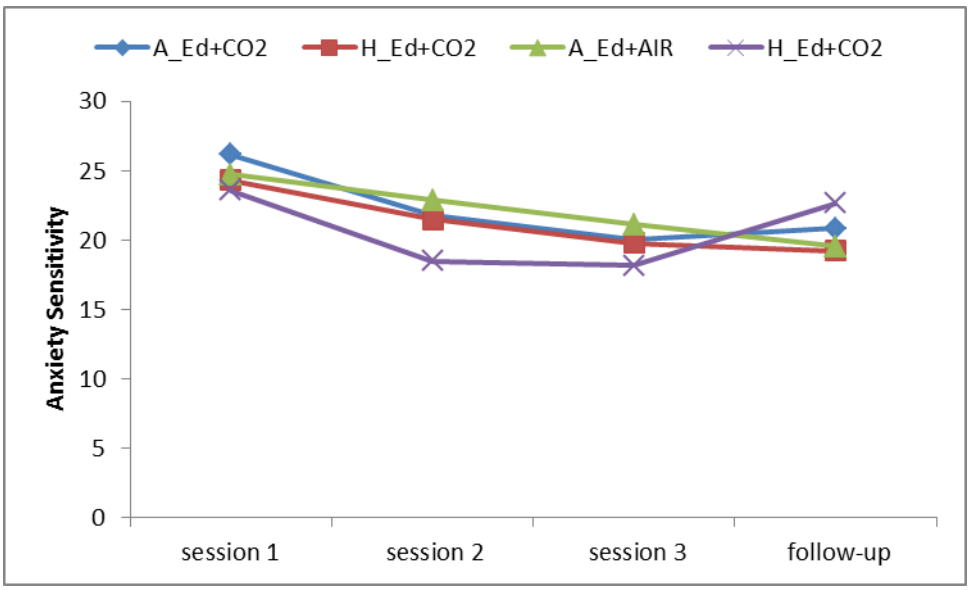


*Figure 5. Reduction in anxiety sensitivity when baseline anxiety sensitivity is at eligibility cutoff*

*Baseline Anxiety Sensitivity Moderates AS Physical Concerns Process*

There was a marginally significant Baseline AS X GAS X EDU X Time$^2$ interaction for the AS physical subscale ($b$= -0.09, $t$(261) = -1.69, $p$ = .10).

The pattern of change for the AS physical concerns was similar to the interaction pattern found for anxiety sensitivity (i.e. full scale). When baseline anxiety sensitivity was severe, the H_Ed conditions displayed declines in AS physical concerns over the intervention sessions and maintenance of these reductions over the follow-up period. The A_Ed + AIR condition also demonstrated reductions in anxiety sensitivity over the intervention sessions but did not fully maintain these reductions over the follow-up period. Among the conditions, A_Ed+CO2 led to the fastest reductions in AS physical concerns and these reductions were maintained over time.

When baseline anxiety sensitivity was at the eligibility cutoff, all active conditions decreased in anxiety sensitivity over intervention sessions and maintained reductions over the follow-up period. Although the double placebo condition (H_Ed+AIR) also demonstrated reductions in anxiety sensitivity over the intervention sessions, it showed a subsequent increase in anxiety sensitivity over the follow-up period.

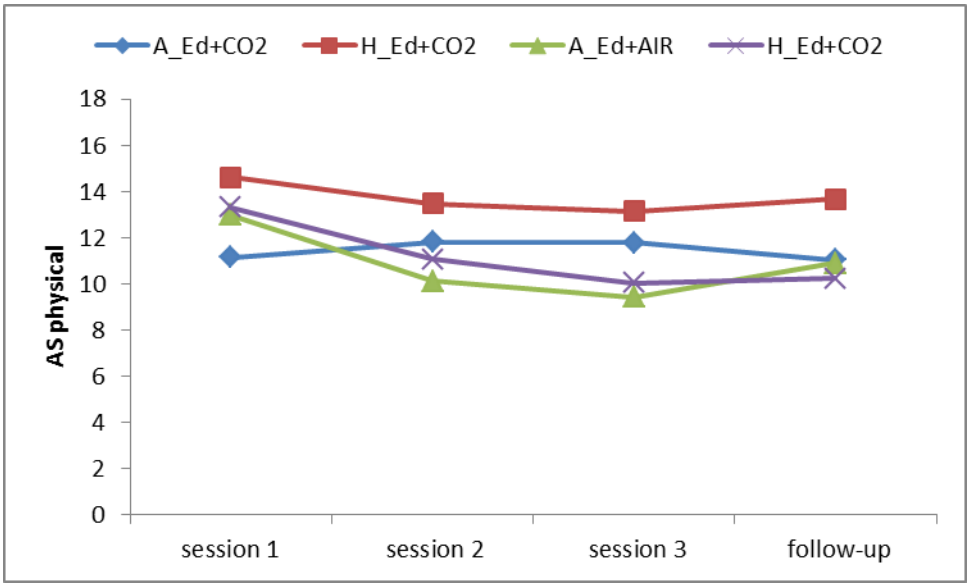


*Figure 6. Reduction in physical subscale when baseline anxiety sensitivity is severe*

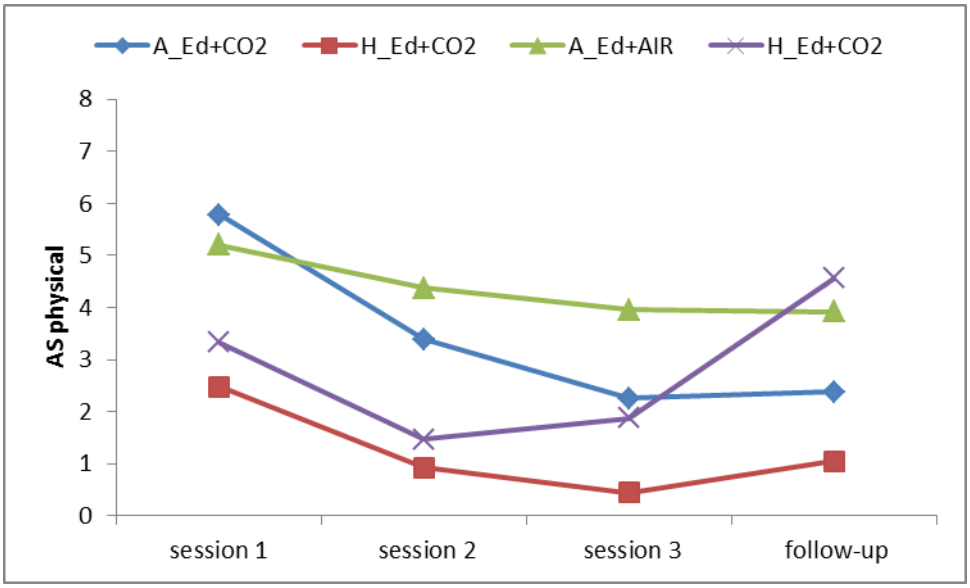


*Figure 7. Reduction in physical subscale when baseline anxiety sensitivity is at eligibility cutoff*

*Baseline Anxiety Sensitivity Moderates AS Social Concerns Process*

For the AS social subscale, there was a marginally significant Baseline AS X GAS X EDU X Time interaction ($b$= .31, $t$(261) = .18, $p$ = .09) as well as a marginally significant Baseline AS X GAS X EDU X Time$^2$ interaction ($b$= -0.11, $t$(261) = -1.98, $p$ = .05).

When baseline anxiety sensitivity was severe, the H_Ed conditions demonstrated reductions in AS social concerns after session 1 and maintained these reductions over the intervention period. In addition, H_Ed conditions displayed additional reductions in social concerns over the follow-up period. The A_Ed + AIR condition decreased in anxiety sensitivity over the intervention sessions but did not fully maintain these reductions over the follow-up period. Among the conditions, A_Ed+CO2 led to the fastest reductions in AS social concerns (by session 1) and these reductions were maintained through the follow-up.

When baseline anxiety sensitivity was at the eligibility cutoff, the A_Ed conditions showed reductions in AS social concerns over time; the A_Ed+CO2 condition maintained its reductions over the follow-up period, while the A_Ed+AIR condition demonstrated additional reductions over the follow-up. The double placebo condition (H_Ed+AIR) also decreased in AS social concerns over the intervention sessions, but did not fully maintain these reductions over the follow-up period. Among the conditions, the H_Ed + CO2 condition showed the least decline over time.

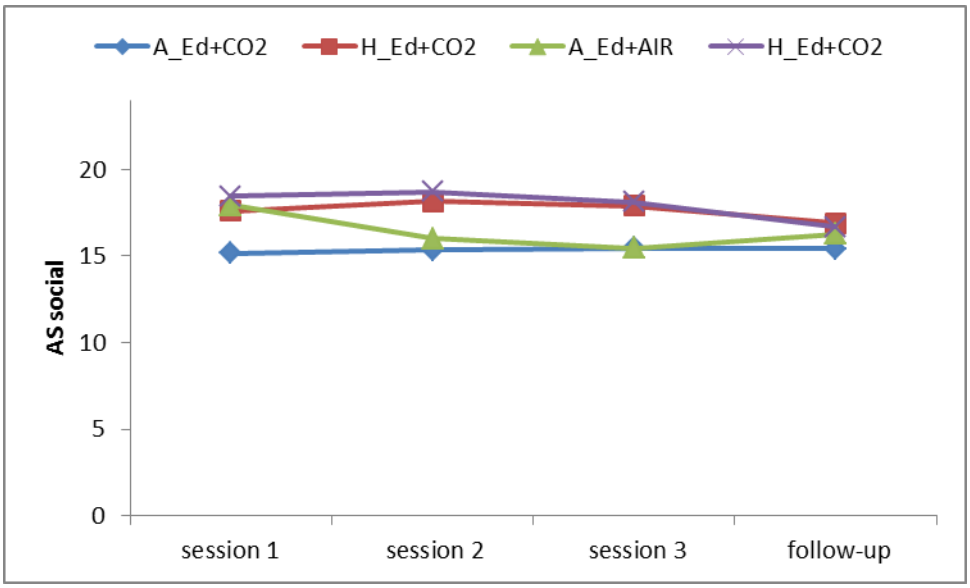


*Figure 8. Reduction in AS social concerns when baseline AS is severe*

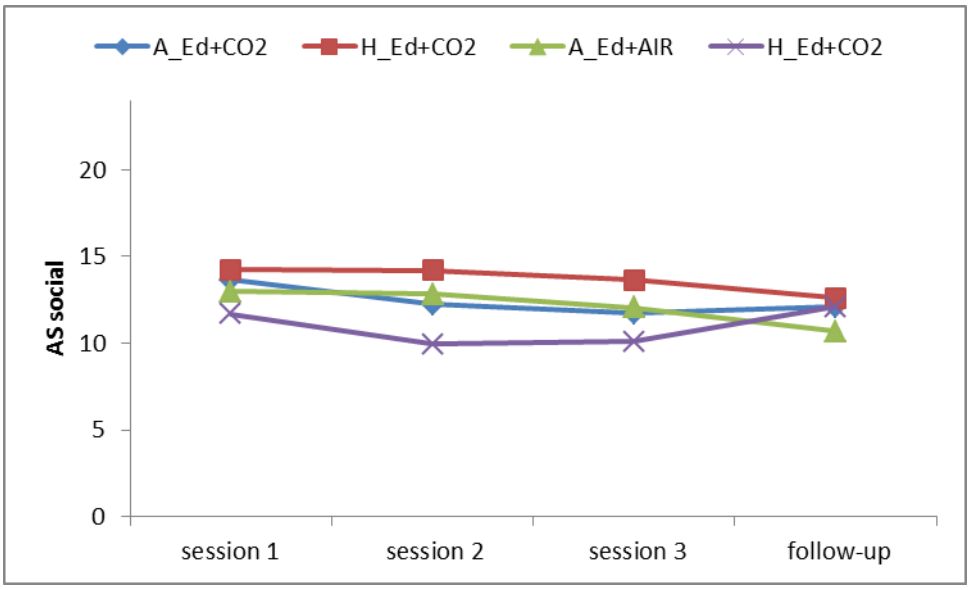


*Figure 9. Reduction in AS social concerns when baseline AS is at eligibility cutoff*

*Baseline Anxiety Sensitivity Moderates AS Cognitive Concerns Process*

For the cognitive subscale, there was a significant Baseline AS X EDU X Time interaction ($b$ = -.17, $t$(269) = -2.21, $p$ = .03) as well as a Baseline AS X EDU X Time$^2$ interaction ($b$ = .06, $t$(269) = 2.27, $p$ = .02). Type of gas mixture was not a significant variable in the final model.

When baseline anxiety sensitivity was severe, the H_Ed and A_Ed conditions led to rapid reductions in the cognitive subscale (after session 1). The A_Ed conditions demonstrated additional reductions over the intervention sessions, but did not fully maintain these reductions over the follow-up period. In contrast, the H_Ed conditions maintained their reductions from session 1 through the follow-up period.

When baseline anxiety sensitivity was at the eligibility cutoff, the A_Ed conditions displayed the greatest reductions in AS cognitive concerns after session 1 and showed additional reductions over time. The H_Ed conditions displayed majority of their gains as a result of sessions 1 and 2, and then maintained these reductions through the follow-up period.

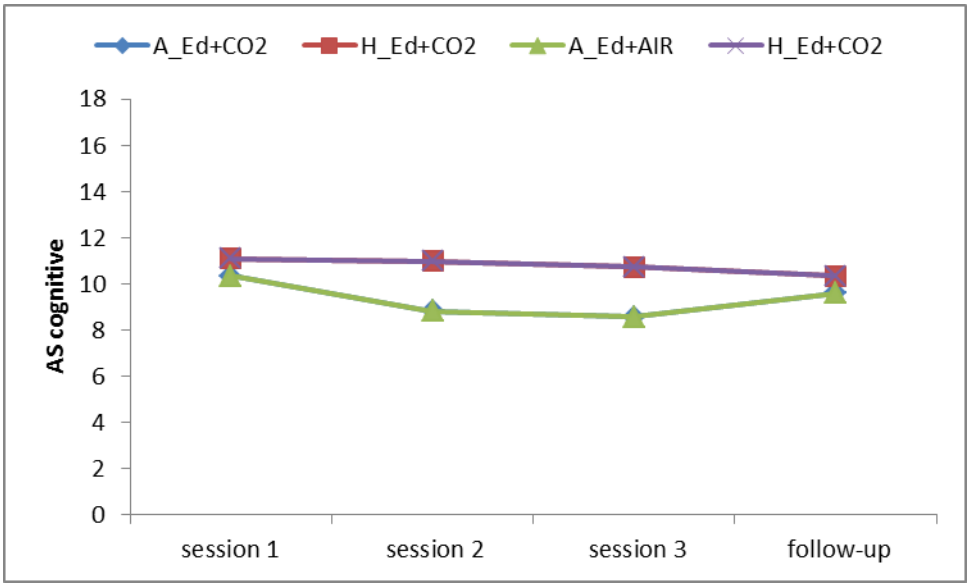


*Figure 10. Reduction in cognitive subscale when baseline AS is severe*

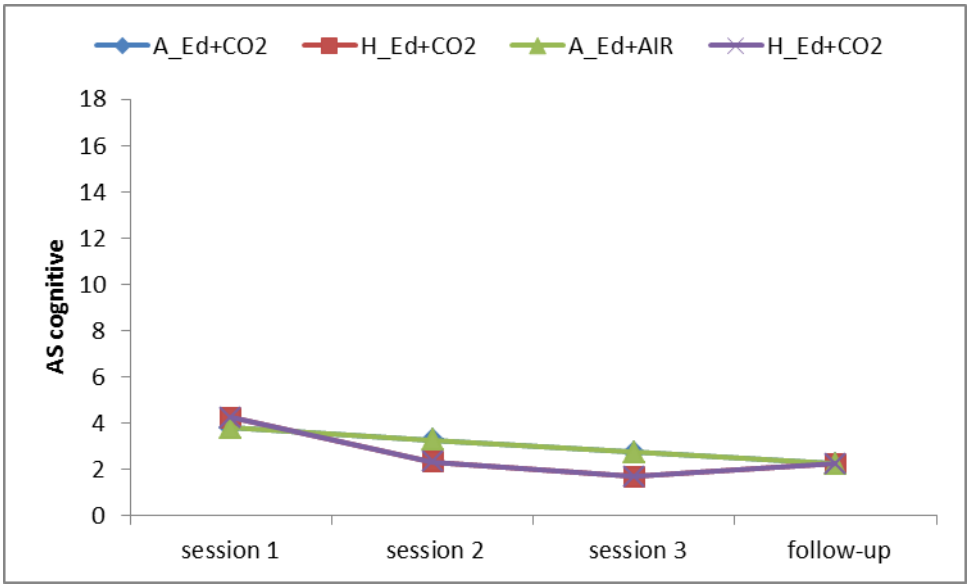


*Figure 11. Reduction in cognitive subscale when baseline AS is at eligibility cutoff*

*Diagnostic Status Moderates Anxiety Sensitivity Process*

For AS full scale, there was a significant Clinical Status X GAS X EDU X time interaction ($b$= -7.00, $t$(219) = -2.91, $p$ = .004).

When there was presence of an anxiety or mood diagnosis, all conditions decreased in anxiety sensitivity through post intervention. Over the follow-up period, the A_Ed+CO2 condition did not fully maintain its reductions while the other conditions exhibited maintenance of levels of anxiety sensitivity.

When participants did not hold a current anxiety or mood diagnosis, all participants demonstrated a decrease in anxiety sensitivity over the intervention sessions. The A_Ed+CO2 condition led to the fastest reductions and maintained reductions over the follow-up period, while other conditions showed additional reductions throughout the intervention period. The A_Ed+AIR condition maintained reductions over the follow-up period, while the H_Ed+CO2 condition exhibited additional reductions over the follow-up. In contrast, the double placebo (H_Ed+AIR) condition did not fully maintain reductions over the follow-up period.

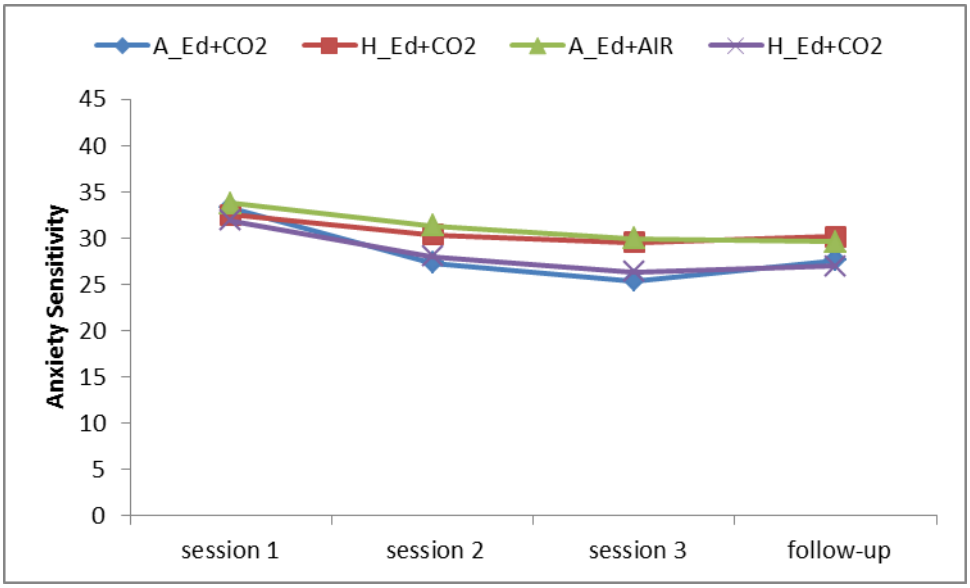


*Figure 12. Reduction in anxiety sensitivity when anxiety or mood diagnosis is present*

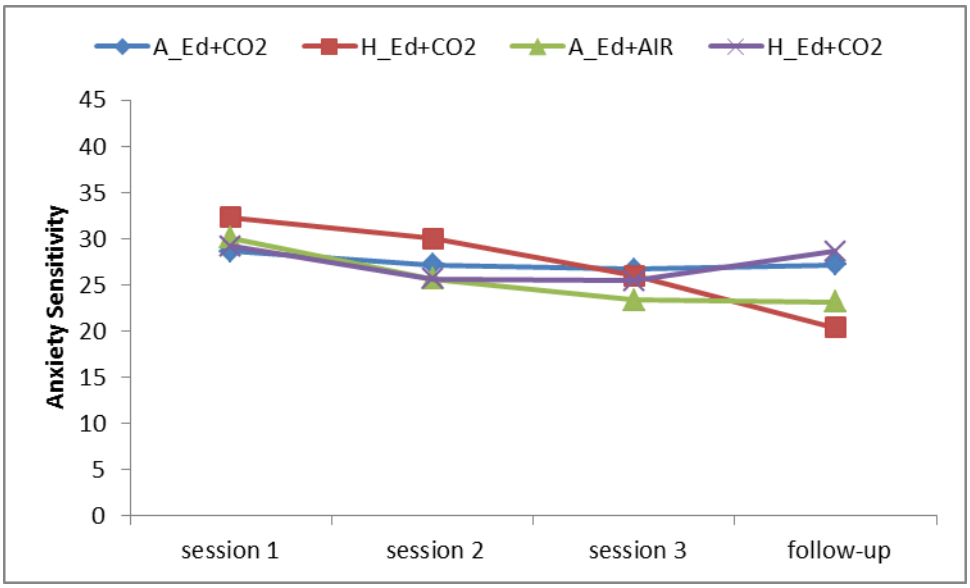


*Figure 13. Reduction in anxiety sensitivity when anxiety or mood diagnosis is not present*

*Diagnostic Status Moderates AS Physical Concerns Process*

Clinical status did not moderate the effects EDU, GAS, or their interaction on change in the AS social and AS cognitive subscales over time. For AS physical subscale, however, there was a Clinical Status X GAS X EDU X Time (*b*= -3.77, *t*(223) = -3.06, *p* = .002).

When there was presence of a current anxiety or mood disorder, the A_Ed+CO2 condition demonstrated reductions in physical concerns through the follow-up period. All other conditions did not fully maintain reductions shown from the intervention period at one-month follow-up.

When participants did not hold a current anxiety or mood diagnosis, the A_Ed conditions showed reductions in AS physical concerns over intervention sessions and maintained these reductions over the follow-up period. The double placebo condition (H_Ed+AIR) also demonstrated reductions in AS physical concerns over the intervention sessions, but did not fully maintain these reductions over the follow-up period. Among the conditions, the H_Ed + CO2 condition displayed the least decline in physical concerns over time.

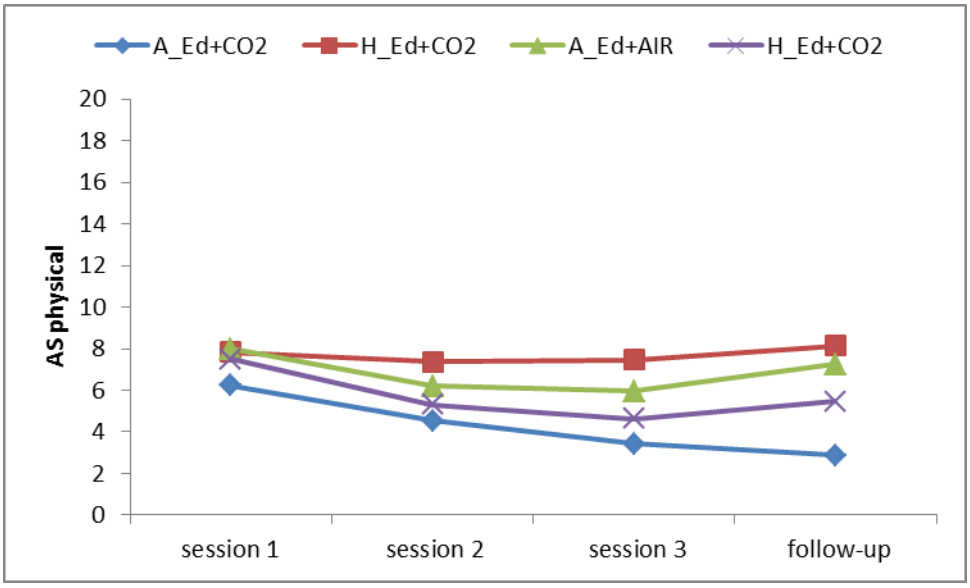


*Figure 14. Reduction in physical subscale when anxiety or mood diagnosis is present*

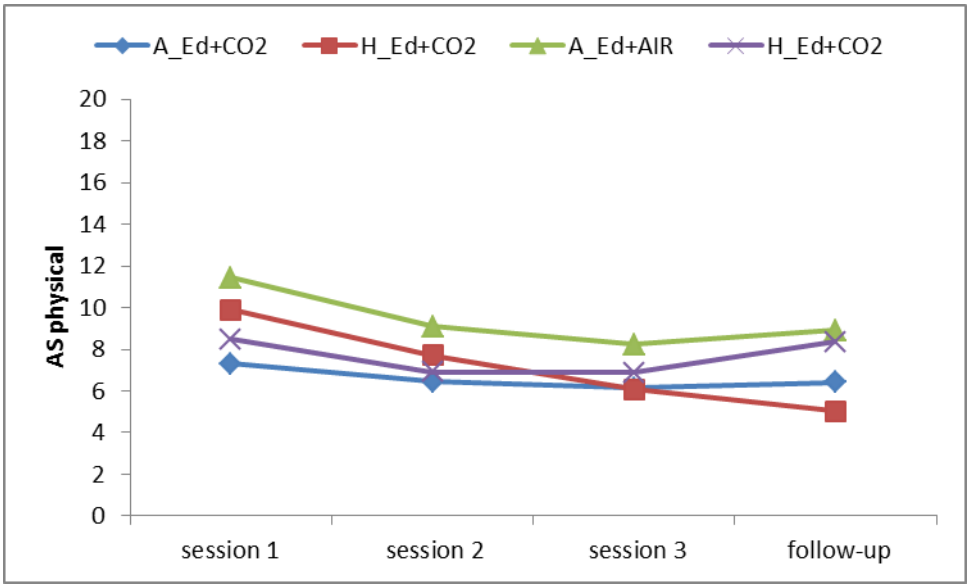


*Figure 15. Reduction in physical subscale when anxiety or mood disorder is not present*

**Fear Habituation to Repeated Inhalations of Gas Mixture**

Separate 2-level HLM analyses were conducted to examine within-session and between-session habituation of fear response for the CO2 conditions and AIR conditions. Because reduction in anxiety sensitivity over time was moderated by baseline anxiety sensitivity and diagnostic status, these variables were examined as moderators for within-session and between-session habituation as well. Therefore, separate analyses were conducted for each moderator and the full model examined Moderator X EDU X Session X Trial$^2$ interaction on fear response to the gas mixture inhalation.

*Fear Habituation in CO2 conditions*

For CO2 conditions, neither diagnostic status nor baseline anxiety sensitivity moderated the effect of EDU on within-session or between-session fear habituation. The final model included a significant Baseline AS X Session interaction ($b$ = -.41, $t$(725) = -2.42, $p$ =.02 and a significant Session X Trial interaction ($b$ = 1.99, $t$(725) = 5.98, $p$ <.0001), suggesting that baseline anxiety sensitivity influenced within and between-session fear habituation to repeated inhalations of gas mixture across CO2 conditions. There was greater between-session and within-session habituation of fear response to CO2 inhalations when baseline anxiety was severe than when baseline anxiety sensitivity was at the eligibility cutoff.

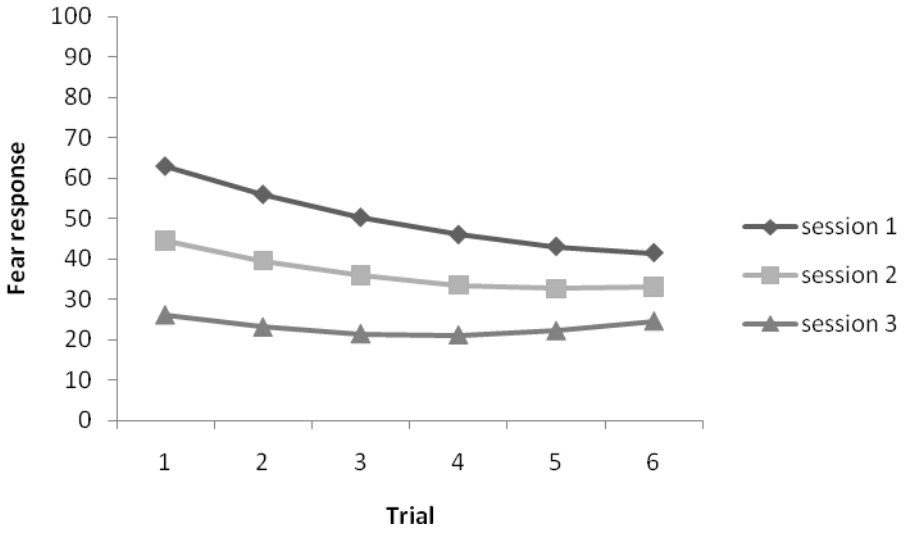


*Figure 16. Fear habituation in CO2 conditions when baseline AS is severe*

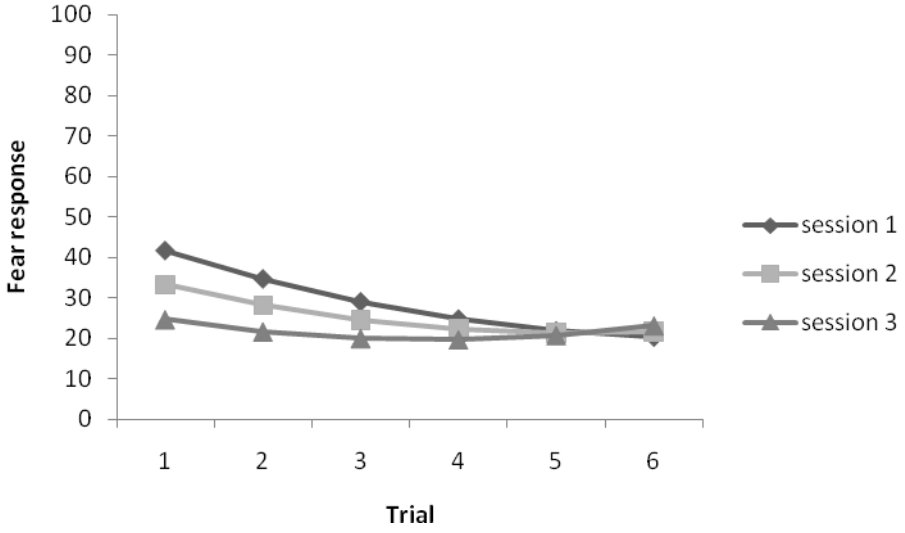


*Figure 17. Fear habituation in CO2 conditions when baseline AS is at eligibility cutoff*

*Fear Habituation in AIR Conditions*

Similar HLM analyses were conducted within AIR conditions. Clinical status did not moderate the effect of EDU on fear response to repeated inhalations of AIR.

When baseline anxiety sensitivity was examined as a moderator, there was a significant EDU X Session X Trial interaction ($b$ = 4.29, $t$(839) = 1.86, $p$ = .02) and a marginally significant EDU X Session X Trial$^2$ interaction predicting habituation in fear response to inhalations of AIR ($b$ = -.67, $t$(839) = -1.88, $p$ = .06).

When baseline AS was severe, participants who received A_Ed showed greater fear habituation to repeated inhalations of AIR than participants who received H_Ed. On the other hand, those who received H_Ed showed greater between-session and within-session habituation to the AIR training as compared to those who received A_Ed when baseline AS was at the eligibility cutoff.

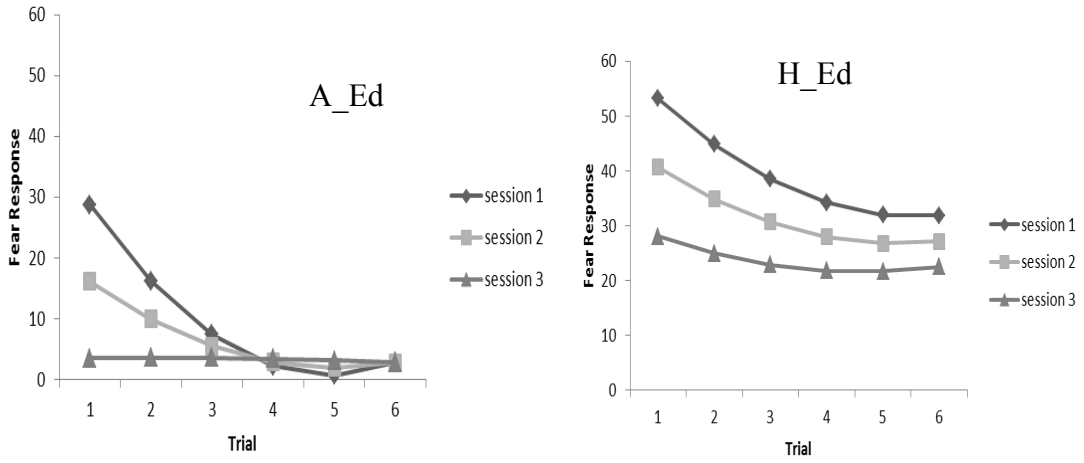


*Figure 18. Fear Habituation in AIR conditions when baseline AS is severe*

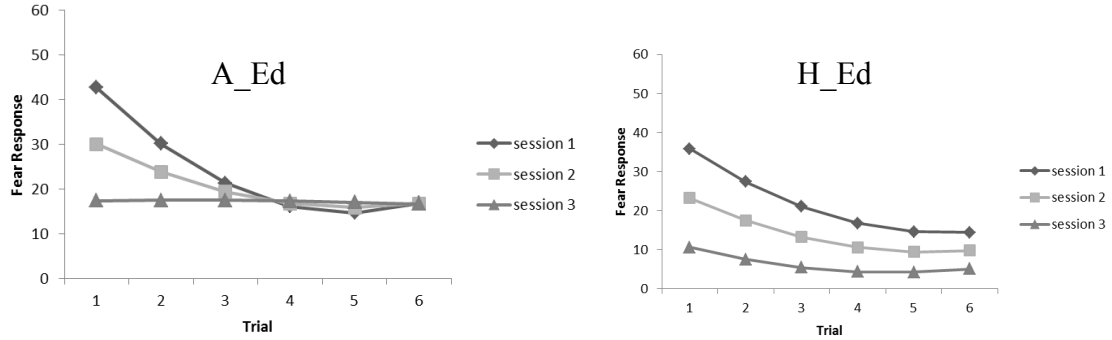


*Figure 19. Fear Habituation in AIR conditions when baseline AS is at eligibility cutoff*

**Mediation Analyses**

It was hypothesized that acceptance and distress tolerance would mediate the interactive effects of GAS X EDU on anxiety sensitivity. Therefore, separate mediation analyses were conducted examining whether the effect of GAS X EDU on anxiety sensitivity was mediated by acceptance and distress tolerance.

Separate mediated moderation analyses were conducted for each subscale of acceptance (willingness, action) and distress tolerance (physical, emotional); the mediator variables were calculated by obtaining residualized scores at session 3 after controlling for baseline scores. Separate models were conducted with residualized anxiety sensitivity at post-intervention and follow-up intervention as outcome variables (after controlling for baseline anxiety sensitivity).

The indirect effect of the interaction of GAS X EDU, after controlling for main effects, on anxiety sensitivity (post-intervention, follow-up) through each of the mediator variables was examined using the methods described by Preacher and Hayes (2007). For each model, multiple regressions were conducted. The path coefficient from GAS X EDU to the mediator and the path coefficient from the mediator variable to outcome variable, was examined. For all examined models, the path coefficients were not significant. Therefore, mediation did not occur.

**POST-HOC POWER ANALYSIS**

In the current sample, the effect size for the observed interaction effect was .021 based on the partial eta2 (which corresponds to f = .15). A post-hoc power analysis was conducted using the G*Power3 program, based on a repeated measure ANOVA model

that included the baseline and post-treatment (or follow-up) scores on the ASI-3. Given that $\alpha = .05$, the average correlation among repeated measures was .59, and the total sample size was 92 (for those who completed follow-up), the achieved statistical power was .74.

# DISCUSSION

The overarching aim of the present study was to enhance knowledge of methods for reducing anxiety sensitivity, a dispositional variable consistently shown to be associated with anxiety disorders as well as other mental health problems. Toward this aim, the present randomized secondary prevention trial sought to examine strategies to reduce anxiety sensitivity among persons with elevated anxiety sensitivity by testing the singular and combined efficacy of two commonly used strategies in multi-component interventions for reducing anxiety sensitivity: (a) anxiety psychoeducation emphasizing the benign nature of stress, and (b) interoceptive exposure (i.e. repeated inhalations of 35% $CO_2$ gas mixture).

Utilizing a 2 X 2 design, all participants received an education component and a component that included repeated inhalations of a gas mixture. To provide a stringent control for non-specific effects associated with anxiety psychoeducation (A_Ed) and interoceptive exposure with $CO_2$ (CO2), two control strategies were included in the study design: general health and nutrition education (H_Ed) and repeated inhalations of regular room air (AIR).

## SELECTION OF ACTIVE INTERVENTION STRATEGIES

Several factors guided the selection of anxiety psychoeducation and interoceptive exposure with $CO_2$ for investigation in the current study. From a public health perspective, prevention programs should be easily disseminable, easily implemented, and

cost-efficient. Although many anxiety sensitivity reduction interventions have included multiple multimodal strategies (Alpblanalp, unpublished dissertation, Gardenswartz & Craske, 2001; Kenardy, McCafferty, & Rosa, 2003), more recent investigations have demonstrated that multicomponent interventions might not be necessary for the reduction of anxiety sensitivity (Schmidt, Eggleston, Woolaway-Bickel, Vasey, Richey, & Fitzpatrick, 2007, Smits, Rosenfield, Behar, Otto, and Powers, 2008).

Anxiety psychoeducation has been commonly included in anxiety sensitivity reduction interventions in at risk populations and is easily disseminable. Interoceptive exposure is often touted as the most important strategy for anxiety sensitivity reduction in clinical settings, but it has not been examined as a singular strategy in at risk populations.

Interoceptive exposure involves repeated exposure to feared physiological sensations until fear is habituated or extinguished. Interoceptive exposure with $CO_2$ has been investigated as an effective treatment strategy for patients with panic disorder (Griez and Van den Hout, 1986; Van den Hout, Van der Molen, Griez, & Lousberg, 1987), but it has not been tested as an intervention strategy within at risk populations. Because the inhalation of $CO_2$ has been shown to consistently elicit fear response among individuals with high anxiety sensitivity (Harrington, Schmidt & Telch; 1996; Zvolensky et al., 1997, 1999), it was predicted that interoceptive exposure with $CO_2$ would serve as an optimal interoceptive exposure strategy for this at risk population.

## CLINICAL EFFICACY

Contrary to predictions, the primary indices of anxiety sensitivity reduction at post-intervention were not significantly affected by type of gas mixture, type of

education, or their interaction. Despite the lack of between-condition effects, all conditions showed significant reductions in indices of anxiety sensitivity including the ASI-3 full scale and its lower order subscales, fear of bodily sensations as indexed by the BSQ, and subjective fear in response to a voluntary hyperventilation challenge. Taken together, these data indicate that anxiety sensitivity was significantly reduced in all conditions.

The pre- to post-intervention within-group Cohen's effect sizes were large in all conditions, ranging from .80 to 1.43. The within-group effect sizes from the present study are comparable to those reported in the eight previously published intervention trials for anxiety sensitivity reduction reported by Smits et al. (2008). In their meta-analysis, the pre- to post-intervention effect size (Cohen's d) for the active intervention groups was 1.03, while the within-condition effect size for the control groups (i.e. psychological placebo or wait-list control) was .65. Therefore, all conditions in the present study exhibited similar effect sizes in comparison to the large effect size found for the intervention groups from the Smits et al. (2008) meta-analysis.

At follow-up, all conditions showed significant reductions in anxiety sensitivity from pre-intervention as well. The within-group effect sizes at follow-up remained large, ranging from .77 to 1.16 (Cohen's d). Similar to findings for post-intervention, most primary indices of anxiety sensitivity were not significantly affected by type of gas mixture, type of education, or their interaction. Although there were no differential effects for continuous measures of anxiety sensitivity at follow-up, participants who

received AIR were more likely to achieve clinically significant reductions in anxiety sensitivity as compared to participants in CO2 conditions at follow-up.

The finding that all conditions showed within group reductions of a magnitude greater than that reported for the control groups in previous studies at post-intervention and follow-up suggests that all conditions in the present study demonstrated meaningful reductions in anxiety sensitivity.

## WHY WAS THERE NO SUPPORT FOR ACTIVE INTERVENTIONS?

### Intervention Manipulation Failure

When differential effects are not fully supported, it is important to consider the effectiveness of manipulation strategies. With regard to the education manipulation, participants watched power-point videos that were previously used in other studies (Schmidt et al., 2007; Feldner et al., 2008). These videos were matched for time and general education, and it was ensured that the health education did not address anxiety or fear of physical sensations. Finally, the videos were administered by undergraduate research assistants who were present while participants watched the videos.

For the inhalation of gas mixture, participants who received $CO_2$ reported greater intensity of sensations to the inhalation of gas mixture as compared to participants who received AIR. This suggests that the gas mixtures were effectively administered and that the $CO_2$ gas mixture produced intense physiological effects. Taken together, it can be assumed that the manipulations were implemented with integrity.

### Regression to the Mean

In the absence of a wait-list control, regression to the mean remains a rival hypothesis to account for the reductions observed from pre-to post-intervention. Although possible, several methodological features of the present study render it unlikely that regression to the mean was responsible for the significant reductions observed from pre-to post-intervention. Specifically, an anxiety sensitivity stability inclusion criterion was imposed such that participants were required to display elevated anxiety sensitivity on two consecutive occasions prior to entering into the study. This criterion resulted in the exclusion of approximately 50% of the screening sample.

**Nonspecific vs. Common Factors**

The large magnitudes of within-condition effects suggest that it is unlikely that the reductions in anxiety sensitivity were accounted for by nonspecific factors, such as reassurance or support provided by research assistants. It is plausible that the within-condition effects were due to common factors that were not intended to cause significant reductions in anxiety sensitivity. For example, Maltby, Mayers, Allen and Tolin (2005) demonstrated that anxiety sensitivity was significantly reduced among persons with high anxiety sensitivity following diagnostic structured interview, even when no intervention for anxiety sensitivity reduction was administered. There were no differences in the reduction shown in anxiety sensitivity between participants who received an intervention following the diagnostic interview and those who did not receive an intervention, however, participants who did not receive a structured clinical interview showed negligible reductions in anxiety sensitivity.

Maltby, Mayers, Allen, and Tolin (2005) argued that the significant reductions demonstrated by groups that received structured clinical interviews might have resulted from normalizing information regarding physical, social and cognitive concerns. The present study included several common factors across conditions that might have affected anxiety sensitivity, including structured diagnostic interviews and behavioral challenge assessments. Therefore, the possibility that such common factors might have contributed to the observed reductions in anxiety sensitivity cannot be ruled out.

**"Control" Strategies as "Active" Strategies**

An alternative explanation for the null effects is that the intended control intervention strategies might have functioned as active intervention strategies. With regard to education, it is unlikely that the health education had an active effect on anxiety sensitivity reduction. The health education that was administered in the present study was used in previous studies as a stand-alone control intervention, and this intervention did not lead to significant within-condition reductions in those studies (Schmidt et a1., 2007, Feldner et al., 2008).

A novel component of this study was the inclusion of exposure sessions with breathing air (AIR) as a control strategy for interoceptive exposure with $CO_2$. The procedure was identical to the procedure for interoceptive exposure with $CO_2$, with the only manipulated variable being the contents of the gas mixture. Although it was intended as a control strategy, repeated inhalations of breathing air might have had a specific effect on anxiety sensitivity that was not predicted. In fact, findings demonstrating that participants who received repeated inhalations of AIR were more

likely to achieve clinically significant change than participants who received interoceptive exposure with $CO_2$ suggest that this strategy that was intended as a placebo might have been a more effective strategy. For example, the process of repeated trials of breathing full-vital capacity inhalations of regular room air might have functioned as a deep breathing exercise and reduced anxiety sensitivity by promoting relaxation.

Participants in all conditions were presented with the rationale for interoceptive exposure and were told that they would be inhaling a gas mixture that might elicit some uncomfortable physiological sensations. Perhaps the experience of undergoing this procedure and not experiencing expected uncomfortable sensations led to increased self-efficacy.

The repeated inhalation of regular room air was not intended to elicit fear response, however, it is plausible that the repeated inhalations of AIR might have functioned as an exposure exercise for non-interoceptive fears. Even though the regular room air did not produce "interoceptive" changes, the overall procedure of repeated inhalations of an unknown gas mixture might have activated fears that are relevant to anxiety sensitivity (i.e. physical, social and cognitive concerns).

**Null Effects for Fear Response to Behavioral Challenges**

It is unexpected that there was not an overall effect of type of gas mixture for fear response to behavioral challenges. It was predicted that interoceptive exposure with $CO_2$ would have a stronger effect on diminishing fear response to the behavioral challenges because of the conceptual match between the specific effects of the intervention strategy

(i.e. repeated exposure to uncomfortable physiological sensations) and the modality of assessment (i.e. behavioral challenge that elicits uncomfortable physiological sensations).

The null effect between repeated inhalations of CO2 and AIR is particularly surprising for fear response to the $CO_2$ challenge at post-intervention and follow-up. For those who had received interoceptive exposure with $CO_2$ during the intervention sessions, the $CO_2$ challenge was no different than the context in which they were trained whereas those who had received AIR during intervention sessions underwent a $CO_2$ inhalation for the first time. This null effect suggests that the actual contents of the gas mixture had little influence on fear response to the behavioral challenges.

Rather, the null findings support that the effects of the repeated inhalations of gas mixture were more likely due to common factors shared across the strategies rather than the specific physiological effects produced by the contents of the gas. It is likely that the context of the situation (i.e. repeated inhalations of an unknown gas) might have led to similar reductions in fear response to the behavioral challenges, regardless of the actual gas mixture. This is consistent with findings from the fear provocation literature that demonstrate that contextual variables such as perceived safety, perceived control, and expectancies influence fear response to biological challenges (Carter, Hollon, Carson, & Shelton, 1995; Sanderson, Rapee, & Barlow, 1989; Telch, Silverman, and Schmidt, 1996; Telch, Smits, Brown, Powers, Lee & Pai, 2010; Zvolensky et al., 1997, 1999).

**Related Psychological Dispositions**

There were significant within-condition reductions for other psychological measures that are related to anxiety sensitivity as well (i.e. trait anxiety, depression). In

fact, within-condition reductions for depression symptoms and fear of bodily sensations from pre-intervention to post-intervention as well as pre-intervention to follow-up had large effect sizes. Therefore, the effects of the interventions tested in the current study were not specific to anxiety sensitivity.

This finding suggests that there might have been common factors associated with these interventions that affected multiple psychological dispositions. Perhaps the normalizing information provided by structured clinical diagnostic interviews influenced reduction in depression symptoms as well. Alternatively, more general factors such as demand characteristics or expectancies might have led to substantial reductions in all psychological variables.

An alternative explanation for the reduction in depression symptoms could be that the reductions in anxiety sensitivity led to subsequent reductions in mood symptoms. For example, Smits et al. (2008) demonstrated that reductions in anxiety sensitivity with exercise mediated the effects of exercise on depression symptoms. Depression symptoms were not assessed during intervention sessions in the present study, but it is possible that the rapid reductions in anxiety sensitivity during the intervention session subsequently led to reductions in mood symptoms.

## PROCESS ANALYSES

### Patterns of Change

Although there were no differential effects of intervention strategies at post-intervention or follow-up, there were between-condition differences when examining

patterns of reductions in anxiety sensitivity and its subscales over the intervention period and follow-up. There were no significant effects of intervention strategies on change in anxiety sensitivity overall, however, differential effects of intervention strategies emerged when examined in the context of moderator variables (i.e. baseline anxiety sensitivity, clinical status).

Two consistent findings were demonstrated. First, the group that received both active intervention strategies (A_Ed+CO2) showed the fastest reductions in anxiety sensitivity and maintained reductions through the follow-up period when baseline anxiety sensitivity was severe. Therefore, for those most "at risk," the combination of anxiety psychoeducation and interoceptive exposure with $CO_2$ might have been the optimal intervention strategy.

Second, the double placebo condition (H_Ed+AIR) did not fully maintain reductions from the intervention period over the one month follow-up when baseline anxiety sensitivity scores were at the cutoff for eligibility requirements for this study. Therefore, for those with milder severity there is evidence that the double placebo condition might not maintain stability of reductions in anxiety sensitivity over time.

**Patterns of Fear Response During Inhalation Sessions**

Consistent with hypotheses, process analyses demonstrated that interoceptive exposure with $CO_2$ led to within-session and between-session habituation. In two case studies examining patterns of fear response, Beck and colleagues (Beck, Shipherd, & Read, 1999; Beck & Wolf, 2001) examined individual patterns of fear reduction to 12 trials of $CO_2$ inhalations. To reduce expectancy effects, participants were told that the

experiment involved the investigation of respiratory control. Participants varied in their individual patterns of fear responding to $CO_2$ inhalations over time. When exposed to 35% $CO_2$ inhalations, 37% of individuals demonstrated habituation, 47% demonstrated sensitization, and 16% remained stable (Beck et al., 1999). In a replication study with 20% $CO_2$ gas inhalations, a greater proportion of individuals displayed habituation, with 67% of participants classified as habituators and 33% classified as nonhabituators (Beck & Wolf, 2001). In the present study, there were no sensitizers when examining patterns of fear response. The difference between fear response patterns in the current study as compared to the previously mentioned studies suggests that the habituation response to interoceptive exposure with $CO_2$ was partly driven by expectancies produced by the intervention rationale.

Contrary to predictions, the AIR conditions showed between-session and within-session habituation as well. Repeated inhalation of AIR was intended as a placebo control for interoceptive exposure with $CO_2$. Although participants were told that the gas mixture they were to inhale might elicit some uncomfortable physiological sensations, it was anticipated that any fear elicited by this task would extinguish once participants received the inhalation of a benign gas mixture. The patterns of fear response suggest that fear was activated and reductions followed a pattern of habituation; this fear response pattern suggests that repeated inhalations of AIR might have functioned as a fear exposure exercise. As the actual contents of the gas mixture produced no physiological effects, the pattern of fear response in conditions that received AIR was most likely a function of the context of the situation.

### Mechanisms of Change

Indices of severity (i.e. baseline anxiety and presence of anxiety or mood disorder) were chosen as putative moderators of intervention effects. It was hypothesized that these variables would increase the effects of the superiority of the active intervention strategies over the control strategies. Attempts to identify moderators of anxiety sensitivity reduction were unsuccessful. Neither baseline anxiety nor diagnostic status interacted with intervention strategies to predict anxiety sensitivity reduction.

Acceptance and distress tolerance were chosen as potential mediators because of their relevance to models of fear reduction for interoceptive exposure. These variables did not mediate effects of active intervention strategies on reduction in anxiety sensitivity.

## IMPLICATIONS

The present study did not support the efficacy of the hypothesized active intervention strategies (i.e. anxiety psychoeducation and interoceptive exposure with $CO_2$) in comparison to the placebo control intervention strategies (i.e. health education and repeated inhalations of regular room air). Rather, all conditions led to significant reductions in anxiety sensitivity scores that were comparable to effect sizes of active interventions in previous randomized prevention studies. In addition, all conditions led to significant differences in indices related anxiety sensitivity, such as fear of bodily sensations and fear response to behavioral challenges. Consistent with previous anxiety sensitivity reduction studies (e.g. Feldner et al., 2008; Schmidt et al., 2007) the present

investigation showed that anxiety sensitivity was significantly reduced following brief interventions (i.e. 3 intervention sessions).

The current study also has implications for the dissemination of prevention programs. The interventions were administered by undergraduate research assistants and did not require highly trained psychology staff. In addition, the education component was delivered via computer which ultimately could be administered at home. Therefore, it is feasible for this type of intervention program to be easily disseminated in a variety of settings.

Findings from the present study also support that brief interventions aimed at reducing anxiety sensitivity might reduce risk for psychopathology. Atlhough a long-term follow-up was not included in the present study, reductions in anxiety sensitivity demonstrated in the current study are comparable to reductions in other prevention studies in which anxiety sensitivity reductions following brief prevention interventions were lasting (e.g. Abplanalp, unpublished dissertation; Gardenswartz & Craske, 2001). The reductions in anxiety sensitivity are also comparable to other reductions seen in other prevention studies in which interventions reduced risk for future psychopathology (e.g. Gardenswartz & Craske, 2001; Schmidt et al, 2007).

The examined interventions in the present study led to significant declines in psychological dispositions (e.g. depression symptoms) that are related to anxiety sensitivity as well, suggesting that these interventions that were designed to reduce anxiety sensitivity might have generalized to various psychological dispositions. Although the stability of these reductions over a long-term follow-up cannot be

determined in the present study, these findings are promising from a prevention standpoint as the interventions might not only target one risk factor (e.g. anxiety sensitivity) but might decrease multiple risk factors for the development and maintenance of psychopathology.

Findings from the present study have implications for methodological considerations for secondary prevention studies as well. All of the conditions in the present study showed greater within-condition effects than wait-list controls and psychological placebo controls in other studies. Relative to stringent controls, there was no support for the efficacy of the hypothesized active intervention strategies of anxiety psychoeducation and interoceptive exposure with $CO_2$.

Based on a meta-analytic review of eight studies examining interventions for anxiety sensitivity reduction in at risk populations, Smits, Berry, Tart, and Powers (2008) concluded that randomized intervention trials offer "sound support" for the efficacy of CBT in reducing anxiety sensitivity in at risk populations. Findings from the present study suggest that research to date have failed to provide stringent tests of CBT intervention strategies; the absence of stringent control conditions might have led researchers to prematurely conclude that the efficacies of tested interventions are related to the "active" effects of these strategies when the interventions might be capitalizing on common factors.

Among the anxiety sensitivity reduction studies in at risk populations, approximately one half of them have included wait-list control conditions (i.e. Gardenswartz & Craske, 2001; Broman-Fulks & Storey, 2008; Kenardy et al., 2003,

Maltby, unpublished dissertation; Smits et al., 2008) Of the five studies that included wait-list control groups, only two randomized prevention trials demonstrated significant differences between the experimental condition and a wait-list condition in the reduction of anxiety sensitivity (Broman-Fulks et al., 2008; Smits et al., 2008). Both studies demonstrated the efficacy of aerobic exercise for the reduction of anxiety sensitivity, however, the experimental design employed in these studies cannot rule out that a large part of the effects of these experimental conditions might have been a result of time spent with research assistants, expectancy, or other simple factors.

Among the previous prevention studies that have utilized psychological placebo control conditions, three of the four have demonstrated efficacy for CBT programs relative to non-specific controls at post-intervention (Abplanalp, unpublished dissertation; Feldner et al., 2008; Schmidt et al, 2008). For example, Apblanalp (unpublished dissertation) demonstrated the efficacy of a CBT package including anxiety pscychoeducation, interoceptive exposure, and breathing retraining compared to an ethics-based education program on the reduction of anxiety sensitivity; these reductions were stable at 1-yr follow-up. In two separate studies, Schmidt et al. (2007) and Feldner et al. (2008) demonstrated that the effects of anxiety psychoeducation and interoceptive exposure led to greater reductions in anxiety sensitivity than a health education control at post-intervention, however, the group differences were not fully maintained over a long-term follow-up. In an investigation of the effects of high intensity aerobic exercise on the reduction of anxiety sensitivity, a stringent placebo control (i.e. low intensity exercise) was employed. Although the high aerobic exercise led to faster declines, there were no

differences between anxiety sensitivity scores between the two groups at post-intervention. Thus, while the studies that have included psychological placebo conditions provided overall support for the efficacy of the tested interventions, the necessity of specific CBT strategies for the reduction of anxiety sensitivity remains unclear.

Most of the randomized intervention trials aimed at reducing anxiety sensitivity in at risk populations have tested CBT intervention strategies or aerobic exercise interventions, with an assumption that exposure to physiological sensations that resemble anxiety-related sensations are beneficial to the reduction of anxiety sensitivity. While some of these intervention strategies might be passive (e.g. anxiety psychoeducation), other strategies might require time, effort, courage, or endurance of uncomfortable feelings (e.g. interoceptive exposure, aerobic exercise). The present study demonstrated that in the presence of a stringent control, active intervention strategies did not provide additional benefit. This raises the question, are the intervention strategies that have been presumed to be efficacious actually necessary?

In the present study, the double placebo condition led to significant reduction in anxiety sensitivity. In fact, participants who received repeated inhalations of AIR were more likely to achieve clinically significant reductions in anxiety sensitivity at follow-up as compared participants who received interoceptive exposure with $CO_2$. Although the difference was not statistically significant, there was also less dropout in the AIR groups than the CO2 conditions. The results demonstrating that the double placebo condition led to similar reductions, if not greater reductions, in anxiety sensitivity as compared to more aversive intervention strategies provides evidence to refute the assumption that

intervention strategies that are employed in treatment protocols for anxiety disorders are necessarily optimal strategies for reduction of anxiety sensitivity in the at risk population.

Despite the general null effects between groups, the differences in patterns of decline in anxiety sensitivity over time suggest that the hypothesized active intervention strategies might be particularly useful under certain conditions. For example, individuals with the highest anxiety sensitivity that received both anxiety psychoeducation and interoceptive exposure with $CO_2$ showed the fastest reductions (after session 1) and maintained these reductions over time. Thus, this type of "active" intervention might not require the full number of sessions and therefore might be considered an optimal intervention for those who are most at risk.

**LIMITATIONS**

Several limitations of the present study are worth mention. Findings from the present study suggest that the observed anxiety sensitivity reductions were accounted for by factors unrelated to the hypothesized active interventions or their combination. In the absence of a no treatment control, the relevant factors that led to significant reductions in the double placebo condition cannot be elucidated. Similarly, certain factors that might have been relevant to the efficacy of the control strategies (e.g. relaxation, self-efficacy) were not assessed.

Although the finding that participants demonstrated significant reductions in anxiety sensitivity from pre-intervention to one-month follow-up following a brief intervention is promising, this brief follow-up period limits the prediction of stability of anxiety sensitivity over time.

The sample consisted mostly of undergraduate students and did not represent individuals with high anxiety sensitivity in the general population. Although this limits the generalizability of the present study, it is relevant to secondary prevention programs. Undergraduate university settings are an ideal setting in which to implement secondary prevention programs as universities have the resources to implement programming that is easily accessible to its students.

### IMPLICATIONS FOR FUTURE RESEARCH

Given that anxiety sensitivity might be easily malleable following simple strategies, future research should examine basic interventions. Future secondary prevention intervention studies should investigate brief, cost-efficient, and palatable strategies in order to develop interventions that would be most easily disseminated and accepted.

Although investigation of simple interventions would be useful, it is also important to investigate strategies to increase the effectiveness of anxiety sensitivity reductions. While most participants in the present study showed significant reductions in anxiety, the means of conditions at post-intervention and follow-up remained in the "risk" zone. In addition, the percentage of participants who achieved clinically significant change in the present study was modest.

As the ultimate goal of reducing anxiety sensitivity in at-risk populations is to reduce risk for psychopathology, longitudinal follow-up studies should be conducted to determine whether the effects on anxiety sensitivity as well as other psychological

measures that are relevant to the development of psychopathology (e.g. depression symptoms) are lasting. In addition, examining change in psychopathology (e.g. incidence, remission, levels of severity) would confirm whether these reductions contributed to reduced risk for future psychopathology.

Finally, future randomized prevention trials for the reduction of anxiety sensitivity in at-risk samples should employ stringent experimental controls. More stringent control conditions are necessary in order to adequately test the specific effects of active interventions on the reduction of anxiety sensitivity and to enhance knowledge of methods to effectively reduce risk for psychopathology.

# Appendix

1. Demographic Questionnaire
2. Medical History Questionnaire (MHQ)
3. Anxiety Sensitivity Index-3 (ASI-3)
4. Body Sensations Questionnaire (BSQ)
5. Behavioral Task Forms
6. State-Trait Anxiety Inventory-Trait subscale (STAI-T)
7. Beck Depression Inventory- II (BDI-II)
8. Brief Fear of Negative Evaluation (BNFE)
9. Interoceptive Exposure Process Measure
10. Acute Panic Inventory (API)
11. Acceptance and Action Questionnaire (AAQ-9)
12. Distress Tolerance Inventory (DTI)
13. Credibility/Expectancy Questionnaire (CEQ)
14. Confidence in Full Capacity Breath

Demographic Questionnaire

Participant #_____

Date_____

Age: ____

Gender: Male / Female

Predominant Ethnicity: ___Black (not Hispanic)

___White (not Hispanic) ___Hispanic

___Asian or Pacific Islander ___American Indian or Alaskan Native

Other (please specify):_____

Semesters of college completed: _____

## Medical History Questionnaire

Please indicate whether you are experiencing or have experienced the following conditions by circling "yes" or "no."

| | | |
|---|---|---|
| Cardiovascular disorder (e.g. cardiac arrythmia, cardiac failure) | Yes | No |
| Respiratory disorder (e.g. asthma, lung fibrosis) | Yes | No |
| High blood pressure | Yes | No |
| Epilepsy | Yes | No |
| Stroke | Yes | No |
| Seizures | Yes | No |
| Have you ever experienced a panic attack? (a panic attack is a sudden rush of fear and urge to flee, along with symptoms such as increased heart rate, sweating, or dizziness) | Yes | No |
| Have you taken psychotropic medication during the past two weeks? | Yes | No |
| For females: Are you currently pregnant or lactating? | Yes | No |

**What is the date of your last menstrual period?** _____

**ASI-3**

Please circle the number that best corresponds to how much you agree with each item. If any items concern something that you have never experienced (e.g., fainting in public) answer on the basis of how you think you might feel *if you had* such an experience. Otherwise, answer all items on the basis of your own experience. Be careful to circle only one number for each item and please answer all items.

| | **Very Little** | **A little** | **Some** | **Much** | **Very much** |
|---|---|---|---|---|---|
| 1. It is important for me not to appear nervous. | 0 | 1 | 2 | 3 | 4 |
| 2. When I cannot keep my mind on a task, I worry that I might be going crazy. | 0 | 1 | 2 | 3 | 4 |
| 3. It scares me when my heart beats rapidly. | 0 | 1 | 2 | 3 | 4 |
| 4. When my stomach is upset, I worry that I might be seriously ill. | 0 | 1 | 2 | 3 | 4 |
| 5. It scares me when I am unable to keep my mind on a task. | 0 | 1 | 2 | 3 | 4 |
| 6. When I tremble in the presence of others, I fear what people might think of me. | 0 | 1 | 2 | 3 | 4 |
| 7. When my chest feels tight, I get scared that I won't be able to breathe properly. | 0 | 1 | 2 | 3 | 4 |
| 8. When I feel pain in my chest, I worry that I am going to have a heart attack. | 0 | 1 | 2 | 3 | 4 |
| 9. I worry that other people will notice my anxiety. | 0 | 1 | 2 | 3 | 4 |
| 10. When I feel "spacey" or spaced out I worry that I may be mentally ill. | 0 | 1 | 2 | 3 | 4 |
| 11. It scares me when I blush in front of people. | 0 | 1 | 2 | 3 | 4 |
| 12. When I notice my heart skipping a beat, I worry that there is something seriously wrong with me. | 0 | 1 | 2 | 3. | 4 |
| 13. When I begin to sweat in a social situation, I fear people will think negatively of me. | 0 | 1 | 2 | 3 | 4 |
| 14. When my thoughts seem to speed up, I worry that I might be going crazy. | 0 | 1 | 2 | 3 | 4 |
| 15. When my throat feels tight, I worry that I could choke to death. | 0 | 1 | 2 | 3 | 4 |
| 16. When I have trouble thinking clearly, I worry that there is something wrong with me. | 0 | 1 | 2 | 3 | 4 |
| 17. I think it would be horrible for me to faint in public. | 0 | 1 | 2 | 3 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| 18. When my mind goes blank, I worry there is something terribly wrong with me. | 0 | 1 | 2 | 3 | 4 |

**BSQ**

Please indicate the degree to which you find the following body sensations distressing **when you are anxious**. Rate the degree to which these feelings are troubling by using the following scale. Write your score in the blank next to each sensation described.

1. Not frightened or worried by this sensation when I am anxious.
2. Rarely frightened or worried by this sensation when I am anxious.
3. Frightened by this sensation about half the time when I am anxious.
4. Frightened by this sensation most of the time when I am anxious.
5. Extremely frightened by this sensation when I am anxious.

_____ Heart palpitations
_____ Pressure in chest
_____ Numbness in arms or legs
_____ Tingling in fingertips
_____ Numbness in another part of your body
(please name that part:_____)
_____ Feeling short of breath
_____ Dizziness
_____ Blurred or distorted vision
_____ Nausea
_____ Butterflies in stomach
_____ Knot in stomach
_____ Lump in throat
_____ Wobbly or rubber legs
_____ Sweating
_____ Dry throat
_____ Feeling disoriented and confused
_____ Feeling disconnected from your body; only partly present

Hyperventilation Form

I will be taking you through a rapid breathing procedure. This procedure will involve having you breathe for a period of 2 minutes at a significantly accelerated pace, approximately three times the rate you normally breathe.

Demonstrate this for participant.
Have the participant model it back for you.

*We are about to start the hyperventilation exercise.*

1. On a scale of 0-100, what is your CURRENT level of fear?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

2. On a scale of 0-100, what is the HIGHEST level of fear you expect to experience at any time during the hyperventilation exercise?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

Hyperventilation Process

1. What is the HIGHEST level of fear you experienced at any time during the hyperventilation exercise?

0 10 20 30 40 50 60 70 80 90 100
*No fear* *Extreme fear*

2.. At any point during the hyperventilation exercise, did you panic? Yes
No

3. At any point during the hyperventilation exercise, did you have the urge to flee? Yes
No

4. Please rate the intensity of the physical sensations.
0 10 20 30 40 50 60 70 80 90 100
*No physical sensations* *Extremely intense*

5. Approximately how long did the physical sensations last? _____ seconds

Rate how strongly you believed the following would occur?

Death
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Passing out/fainting
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Suffocation
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Heart Attack
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Loss of Control
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Embarrassment
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Going Crazy
0 10 20 30 40 50 60 70 80 90 100

Straw-breathing Form

For the next challenge, I will ask you to breathe through a coffee straw. Please pinch your nose so that you can only breathe through your mouth. You should then breathe through the straw until I ask you to stop.

*We are about to start the straw-breathing exercise.*

1. On a scale of 0-100, what is your CURRENT level of fear?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

2. On a scale of 0-100, What is the HIGHEST level of fear you expect to experience at any time during the straw-breathing exercise?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

RA should record number of seconds completed _____

Straw-breathing Process

1. What is the HIGHEST level of fear you experienced at any time during the straw-breathing exercise?

0 10 20 30 40 50 60 70 80 90 100
*No fear* *Extreme fear*

2.. At any point during the straw-breathing exercise, did you panic? Yes
No

3. At any point during the straw-breathing exercise, did you have the urge to flee? Yes
No

4. Please rate the intensity of the physical sensations.
0 10 20 30 40 50 60 70 80 90 100
*No physical sensations* *Extremely intense*

5. Approximately how long did the physical sensations last? _____ seconds

Rate how strongly you believed the following would occur?

Death
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Passing out/fainting
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Suffocation
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Heart Attack
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Loss of Control
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Embarrassment
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Going Crazy
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Spinning Form

For the next challenge, I will spin you in this swivel chair.

*We are about to start the spinning exercise.*

1. On a scale of 0-100, what is your CURRENT level of fear?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

2. On a scale of 0-100, What is the HIGHEST level of fear you expect to experience at any time during the spinning exercise?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

RA should record number of seconds completed _____

Spinning Process

1. What is the HIGHEST level of fear you experienced at any time during the spinning exercise?

0 10 20 30 40 50 60 70 80 90 100
*No fear* *Extreme fear*

2.. At any point during the spinning exercise, did you panic? Yes
No

3. At any point during the spinning exercise, did you have the urge to flee? Yes
No

4. Please rate the intensity of the physical sensations.
0 10 20 30 40 50 60 70 80 90 100
*No physical sensations* *Extremely intense*

5. Approximately how long did the physical sensations last? _____ seconds

Rate how strongly you believed the following would occur?

Death
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Passing out/fainting
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Suffocation
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Heart Attack
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Loss of Control
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Embarrassment
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Going Crazy
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

**STAI-T**

**Instructions:** A number of statements which people have used to describe themselves are given below. Read each statement carefully and respond to it by writing down a number between 1 and 4 next to each statement. Use the number that best indicates that best indicates how you *generally* feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer that seems to describe you generally feel. The possible ratings are presented in the scale below.

1 = Almost never 2 = Sometimes
3 = Often 4 = Almost always

| | | | | |
|---|---|---|---|---|
| 1. I feel pleasant. | 1 | 2 | 3 | 4 |
| 2. I feel nervous and restless. | 1 | 2 | 3 | 4 |
| 3. I feel satisfied with myself. | 1 | 2 | 3 | 4 |
| 4. I wish I could be as happy as others seem to be. | 1 | 2 | 3 | 4 |
| 5. I feel like a failure. | 1 | 2 | 3 | 4 |
| 6. I feel rested. | 1 | 2 | 3 | 4 |
| 7. I am "calm, cool, and collected." | 1 | 2 | 3 | 4 |
| 8. I feel that difficulties are piling up so that I cannot overcome them. | 1 | 2 | 3 | 4 |
| 9. I worry too much over something that really does not matter. | 1 | 2 | 3 | 4 |
| 10.I am happy. | 1 | 2 | 3 | 4 |
| 11. I have disturbing thoughts. | 1 | 2 | 3 | 4 |
| 12. I lack self-confidence. | 1 | 2 | 3 | 4 |
| 13. I feel secure. | 1 | 2 | 3 | 4 |
| 14. I make decisions easily. | 1 | 2 | 3 | 4 |
| 15. I feel inadequate. | 1 | 2 | 3 | 4 |
| 16. I am content. | 1 | 2 | 3 | 4 |
| 17. Some unimportant thought runs through my mind and bothers me. | 1 | 2 | 3 | 4 |
| 18. I take disappointments so keenly that I can't put them out of my mind. | 1 | 2 | 3 | 4 |
| 19. I am a steady person. | 1 | 2 | 3 | 4 |
| 20. I get in a state of tension or turmoil as I think over my recent concerns and interests. | 1 | 2 | 3 | 4 |

BDI

The following 21 questions measures recent symptoms of depression. Please read each group of statement carefully, and then circle the one statement in each group that best describes the way you have been feeling during the past two weeks, including today.

1. Sadness
I do not feel sad.
I feel sad much of the time.
I am sad all the time.
I am so sad or unhappy that I can't stand it.

2. Pessimism
I am not discouraged about my future.
I feel more discouraged about my future than I used to be.
I do not expect things to work out for me.
I feel my future is hopeless and will only get worse.

3. Past Failure
I do not feel like a failure.
I have failed more than I should have.
As I look back, I see a lot of failures.
I feel I am a total failure as a person.

4. Loss of Pleasure
I get as much pleasure as I ever did from the things I enjoy.
I don't enjoy things as much as I used to.
I get very little pleasure from the things I used to enjoy.
I can't get any pleasure from the things I used to enjoy.

5. Guilty Feelings
I don't feel particularly guilty.
I feel guilty over many things I have done or should have done.
I feel quite guilty most of the time.
I feel guilty all of the time.

6. Punishment Feelings
I don't feel I am being punished.
I feel I may be punished.
I expect to be punished.
I feel I am being punished.

7. Self-Dislike
I feel the same about myself as ever.
I have lost confidence in myself.
I am disappointed in myself.
I dislike myself.

8. Self-Criticalness
I don't criticize or blame myself more than usual.
I am more critical of myself than I used to be.

I criticize myself for all of my faults.
I blame myself for everything bad that happens.

9. Suicidal Thoughts or Wishes
I don't have any thoughts of killing myself.
I have thoughts of killing myself, but I would not carry them out.
I would like to kill myself.
I would kill myself if I had the chance.

10. Crying
I don't cry any more than I used to.
I cry more than I used to.
I cry over every little thing.
I feel like crying, but I can't.

11. Agitation
I am no more restless or wound up than usual.
I feel more restless or wound up than usual.
I am so restless or agitated that it's hard to stay still.
I am so restless or agitated that I have to keep moving or doing something.

12. Loss of Interest
I have not lost interest in other people or activities.
I am less interested in other people or thins than before.
I have lost most of my interest in other people or things.
It's hard to get interested in anything.

13. Indecisiveness
I make decisions about as well as ever.
I find it more difficult to make decisions than usual..
I have much greater difficulty in making decisions than I used to..
I have trouble making any decisions.

14. Worthlessness
I do not feel I am worthless..
I don't consider myself as worthwhile and useful as I used to..
I feel more worthless as compared to other people..
I feel utterly worthless.

15. Loss of Energy
I have as much energy as ever.
I have less energy than I used to have.
I don't have enough energy to do very much.
I don't have enough energy to do anything.

16. Changes in Sleeping Pattern
I have not experienced any change in my sleeping pattern..
---
I sleep somewhat more than usual. (OR)
I sleep somewhat less than usual.
---
I sleep a lot more than usual. (OR)
I sleep a lot less than usual.

---
I sleep most of the day (OR)
I wake up 1-2 hours early and can't get back to sleep.

17. Irritability
I am no more irritable than usual.
I am more irritable than usual.
I am much more irritable than usual.
I am irritable all the time.

18. Changes in Appetite
I have not experienced any change in my appetite.
---
My appetite is somewhat less than usual.
My appetite is somewhat greater than usual.
---
My appetite is much less than before.
My appetite is much greater than usual.
---
I have no appetite at all.
I crave food all the time.

19. Concentration Difficulty
I can concentrate as well as ever.
I can't concentrate as well as usual.
It's hard to keep my mind on anything for very long.
I find I can't concentrate on anything.

20. Tiredness or Fatigue
I am no more tired or fatigued than usual.
I get more tired or fatigued more easily than usual.
I am too tired or fatigued to do a lot of the things I used to do.
I am too tired or fatigued to do most of the things I used to do.

21. Loss of Interest in Sex
I have not noticed any recent change in my interest in sex.
I am less interested in sex than I used to be.
I am much less interested in sex now.
I have lost interest in sex completely.

# Brief FNE

This section is concerned with thoughts or feelings people may have in social situations. Please read each item carefully and rate the degree to which each item is characteristic of you on a scale from 1 (not at all characteristic of me) to 5 (extremely characteristic of me).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. I worry about what people will think of me even when I know it doesn't make any difference. | 0 | 1 | 2 | 3 | 4 | 5 |
| 2. I am unconcerned even if I know people are forming on unfavorable impression of me. | 0 | 1 | 2 | 3 | 4 | 5 |
| 3. I am frequently afraid of other people noting my shortcomings. | 0 | 1 | 2 | 3 | 4 | 5 |
| 4. I rarely worry about what kind of impression I am making on someone. | 0 | 1 | 2 | 3 | 4 | 5 |
| 5. I am afraid that others will not approve of me. | 0 | 1 | 2 | 3 | 4 | 5 |
| 6. I am afraid that people will find fault with me. | 0 | 1 | 2 | 3 | 4 | 5 |
| 7. Other people’s opinions of me do not bother me. | 0 | 1 | 2 | 3 | 4 | 5 |
| 8. When I am talking to someone, I worry about what they may be thinking about me. | 0 | 1 | 2 | 3 | 4 | 5 |
| 9. I am usually worried about what kind of impression I make | 0 | 1 | 2 | 3 | 4 | 5 |
| 10. If I know someone is judging me, it has little effect on me. | 0 | 1 | 2 | 3 | 4 | 5 |
| 11. Sometimes I think I am too concerned with what other people think of me. | 0 | 1 | 2 | 3 | 4 | 5 |
| 12. I often worry that I will say or do the wrong things. | 0 | 1 | 2 | 3 | 4 | 5 |

**Treatment ID _____**
**Condition _____**
**Date _____**
**Session _____**
**RA _____**

**Pre-Trial 1**
(asked by research assistant 20 seconds before the next trial)

***"We will now begin the first trial"***

1. On a scale of 0-100, what is your CURRENT level of fear?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

2. On a scale of 0-100, What is the HIGHEST level of fear you expect to experience at any time during the next trial?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

**Post-Trial 1**

1. What is the HIGHEST level of fear you experienced at any time during the trial?

0 10 20 30 40 50 60 70 80 90 100
*No fear* *Extreme fear*

2.. At any point during the trial, did you panic? Yes No

3. At any point during the trial, did you have the urge to flee? Yes No

4. Please rate the intensity of the physical sensations.

0 10 20 30 40 50 60 70 80 90 100
*No physical sensations* *Extremely intense*

5. Approximately how long did the physical sensations last? _____ seconds

Rate how strongly you believed the following would occur?

Death
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Passing out/fainting
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Suffocation
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Heart Attack
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Loss of Control
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Embarrassment
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Going Crazy
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

**Pre-Trial 2**
(asked by research assistant 20 seconds before the next trial)

***"We will now begin the next trial"***

1. On a scale of 0-100, what is your CURRENT level of fear?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

2. On a scale of 0-100, What is the HIGHEST level of fear you expect to experience at any time during the next trial?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

**Post-Trial 2**

1. What is the HIGHEST level of fear you experienced at any time during the trial?

0 10 20 30 40 50 60 70 80 90 100
*No fear* *Extreme fear*

2.. At any point during the trial, did you panic? Yes No

3. At any point during the trial, did you have the urge to flee? Yes No

4. Please rate the intensity of the physical sensations.

0 10 20 30 40 50 60 70 80 90 100
*No physical sensations* *Extremely intense*

5. Approximately how long did the physical sensations last? _____ seconds

Rate how strongly you believed the following would occur?

Death
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Passing out/fainting
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Suffocation
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Heart Attack
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Loss of Control
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Embarrassment
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Going Crazy
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

**Pre-Trial 3**
(asked by research assistant 20 seconds before the next trial)

***"We will now begin the next trial"***

1. On a scale of 0-100, what is your CURRENT level of fear?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

2. On a scale of 0-100, What is the HIGHEST level of fear you expect to experience at any time during the next trial?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

**Post-Trial 3**

1. What is the HIGHEST level of fear you experienced at any time during the trial?

0 10 20 30 40 50 60 70 80 90 100
*No fear* *Extreme fear*

2.. At any point during the trial, did you panic? Yes No

3. At any point during the trial, did you have the urge to flee? Yes No

4. Please rate the intensity of the physical sensations.

0 10 20 30 40 50 60 70 80 90 100
*No physical sensations* *Extremely intense*

5. Approximately how long did the physical sensations last? _____ seconds

Rate how strongly you believed the following would occur?

Death
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Passing out/fainting
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Suffocation
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Heart Attack
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Loss of Control
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Embarrassment
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Going Crazy
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

**Pre-Trial 4**
(asked by research assistant 20 seconds before the next trial)

***"We will now begin the next trial"***

1. On a scale of 0-100, what is your CURRENT level of fear?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | *Extreme fear* | |

2. On a scale of 0-100, What is the HIGHEST level of fear you expect to experience at any time during the next trial?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | *Extreme fear* | |

**Post-Trial 4**

1. What is the HIGHEST level of fear you experienced at any time during the trial?

0 10 20 30 40 50 60 70 80 90 100
*No fear* *Extreme fear*

2.. At any point during the trial, did you panic? Yes No

3. At any point during the trial, did you have the urge to flee? Yes No

4. Please rate the intensity of the physical sensations.

0 10 20 30 40 50 60 70 80 90 100
*No physical sensations* *Extremely intense*

5. Approximately how long did the physical sensations last? _____ seconds

Rate how strongly you believed the following would occur?

Death
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Passing out/fainting
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Suffocation
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Heart Attack
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Loss of Control
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Embarrassment
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Going Crazy
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

**Pre-Trial 5**
(asked by research assistant 20 seconds before the next trial)

***"We will now begin the next trial"***

1. On a scale of 0-100, what is your CURRENT level of fear?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

2. On a scale of 0-100, What is the HIGHEST level of fear you expect to experience at any time during the next trial?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

**Post-Trial 5**

1. What is the HIGHEST level of fear you experienced at any time during the trial?

0 10 20 30 40 50 60 70 80 90 100
*No fear* *Extreme fear*

2.. At any point during the trial, did you panic? Yes No

3. At any point during the trial, did you have the urge to flee? Yes No

4. Please rate the intensity of the physical sensations.

0 10 20 30 40 50 60 70 80 90 100
*No physical sensations* *Extremely intense*

5. Approximately how long did the physical sensations last? _____ seconds

Rate how strongly you believed the following would occur?

Death
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Passing out/fainting
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Suffocation
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Heart Attack
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Loss of Control
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Embarrassment
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Going Crazy
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

**Pre-Trial 6**
(asked by research assistant 20 seconds before the next trial)

***"We will now begin the next trial"***

1. On a scale of 0-100, what is your CURRENT level of fear?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

2. On a scale of 0-100, What is the HIGHEST level of fear you expect to experience at any time during the next trial?

| 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|
| *No fear* | | | | | | | | | | *Extreme fear* |

**Post-Trial 6**

1. What is the HIGHEST level of fear you experienced at any time during the trial?

0 10 20 30 40 50 60 70 80 90 100
*No fear* *Extreme fear*

2.. At any point during the trial, did you panic? Yes No

3. At any point during the trial, did you have the urge to flee? Yes No

4. Please rate the intensity of the physical sensations.

0 10 20 30 40 50 60 70 80 90 100
*No physical sensations* *Extremely intense*

5. Approximately how long did the physical sensations last? _____ seconds

Rate how strongly you believed the following would occur?

Death
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Passing out/fainting
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Suffocation
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Heart Attack
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Loss of Control
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Embarrassment
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

Going Crazy
0 10 20 30 40 50 60 70 80 90 100
*Not at all* *Strongly believed*

**API**

Participant #:_____ Date:_____

For each symptom listed, please rate the greatest severity you experienced after any inhalation.
(For each symptom circle one number.)

| | Absent | Mild | Moderate | Severe |
|---|---|---|---|---|
| Did you feel faint? | 0 | 1 | 2 | 3 |
| Were you afraid of dying? | 0 | 1 | 2 | 3 |
| Were you afraid in general? | 0 | 1 | 2 | 3 |
| Did you have palpitations? | 0 | 1 | 2 | 3 |
| Was it hard for you to breathe or to catch your breath? | 0 | 1 | 2 | 3 |
| Did you have an urge to urinate? | 0 | 1 | 2 | 3 |
| Did you have the urge to defecate? | 0 | 1 | 2 | 3 |
| Did you feel dizzy or lightheaded? | 0 | 1 | 2 | 3 |
| Did you feel confused at all? | 0 | 1 | 2 | 3 |
| Did things and people seem unreal? | 0 | 1 | 2 | 3 |
| Did you feel detached from part or all of your body? | 0 | 1 | 2 | 3 |
| Was it hard for you to concentrate? | 0 | 1 | 2 | 3 |
| Were you sweating at all? | 0 | 1 | 2 | 3 |
| Was it difficult for you to speak? | 0 | 1 | 2 | 3 |
| Was it be difficult for you to do your job? (apart from being hooked up?) | 0 | 1 | 2 | 3 |
| Did you have any inner shakiness, twitching, or trembling? | 0 | 1 | 2 | 3 |
| Did you feel nauseous or uneasy? | 0 | 1 | 2 | 3 |

| | | | | |
|---|---|---|---|---|
| Were you afraid of going crazy? | 0 | 1 | 2 | 3 |
| Were you afraid of losing control? | 0 | 1 | 2 | 3 |
| Did you have any tingling or numbness? | 0 | 1 | 2 | 3 |
| Were you experiencing any chest pain or discomfort? | 0 | 1 | 2 | 3 |
| Did you have any difficulty in swallowing? | 0 | 1 | 2 | 3 |
| Were you feeling any choking or smothering sensations? | 0 | 1 | 2 | 3 |
| Were you feeling any hot or cold flashes? | 0 | 1 | 2 | 3 |
| Was your mouth dry? | 0 | 1 | 2 | 3 |
| Did you feel weak? | 0 | 1 | 2 | 3 |
| Did you have a desire to flee? | 0 | 1 | 2 | 3 |
| Did you feel depressed? | 0 | 1 | 2 | 3 |
| Were you feeling embarrassed or humiliated? | 0 | 1 | 2 | 3 |

**The Acceptance and Action Questionnaire – Revised**

Below you will find a list of statements. Please rate the truth of each statement as it applies to you. Use the following scale to make your choice.

1----------2----------3----------4----------5----------6----------7

| never true | very seldom true | seldom true | sometimes true | frequently true | almost always true |
|---|---|---|---|---|---|

_____ 1. I am able to take action on a problem even if I am uncertain what is the right thing to do.

_____ 2. When I feel depressed or anxious, I am unable to take care of my responsibilities.

_____ 3. I rarely worry about getting my anxieties, worries, and feelings under control.

_____ 4. I'm not afraid of my feelings.

_____ 5. Anxiety is bad.

_____ 6. If I could magically remove all the painful experiences I've had in my life, I would do so.

_____ 7. I often catch myself daydreaming about things I've done and what I would do differently next time.

_____ 8. When I evaluate something negatively, I usually recognize that this is just a reaction, not an objective fact.

_____ 9. When I compare myself to other people, it seems that most of them are handling their lives better than I do.

**Distress Tolerance Inventory**

INSTRUCTIONS: For each of the statements listed below, please select the response that *best* describes how much you agree or disagree with the statement as it applies to how you are normally.

1. I can usually handle feelings of emotional upset quite well.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly Agree | Agree | Slightly Agree | Slightly Disagree | Disagree | Strongly Disagree |

2. I usually face emotionally upsetting situations head on.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly Agree | Agree | Slightly Agree | Slightly Disagree | Disagree | Strongly Disagree |

3. I usually follow through with tasks that are emotionally upsetting.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly Agree | Agree | Slightly Agree | Slightly Disagree | Disagree | Strongly Disagree |

4. I am able to handle feelings of emotional upset as well as most people.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly Agree | Agree | Slightly Agree | Slightly Disagree | Disagree | Strongly Disagree |

5. When faced with the choice of either facing an upsetting situation or avoiding it, I usually avoid it even if facing the situation is in my best interest.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly Agree | Agree | Slightly Agree | Slightly Disagree | Disagree | Strongly Disagree |

6. I'll take fairly extreme measures to stop physical discomfort or pain.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly Agree | Agree | Slightly Agree | Slightly Disagree | Disagree | Strongly Disagree |

7. I am a real wimp when it comes to handling any kind of physical discomfort or pain.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly Agree | Agree | Slightly Agree | Slightly Disagree | Disagree | Strongly Disagree |

8. I have a high threshold for pain or other physical discomfort.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly Agree | Agree | Slightly Agree | Slightly Disagree | Disagree | Strongly Disagree |

9. I can handle quite a bit of physical pain or physical discomfort.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly Agree | Agree | Slightly Agree | Slightly Disagree | Disagree | Strongly Disagree |

10. Pain and other forms of physical distress do not bother me much.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Strongly Agree | Agree | Slightly Agree | Slightly Disagree | Disagree | Strongly Disagree |

CEQ

1. At this point, how logical does the intervention offered to you seem?
1 2 3 4 5 6 7 8 9
not at all logical somewhat logical very logical

2. At this point, how successful do you think this intervention will be in reducing your anxiety sensitivity?
1 2 3 4 5 6 7 8 9
not at all useful somewhat useful very useful

3. How confident would you be in recommending this intervention to a friend with anxiety sensitivity?
1 2 3 4 5 6 7 8 9
not at all confident somewhat confident very confident

4. By the end of the intervention period, how much improvement in your anxiety sensitivity do you think will occur?
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Confidence in Full Capacity Breath

1. How confident are you that the participant inhaled a complete, full capacity breath on the last trial?
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

2. How confident are you that the participant inhaled a complete, full capacity breath on the last trial?
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

3. How confident are you that the participant inhaled a complete, full capacity breath on the last trial?
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4. How confident are you that the participant inhaled a complete, full capacity breath on the last trial?
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

5. How confident are you that the participant inhaled a complete, full capacity breath on the last trial?
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

6. How confident are you that the participant inhaled a complete, full capacity breath on the last trial?
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

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# Vita

Anushka Pai received her Bachelor of Arts degree from Trinity University in 2003, where she graduated magna cum laude with honors in psychology. After working as a research assistant at the Center for the Treatment and Study of Anxiety at the University of Pennsylvania, she entered the doctoral program in clinical psychology at the University of Texas at Austin in the Fall semester of 2005. Since then, she has studied the nature and treatment of anxiety under the supervision of Michael J. Telch in the Laboratory for the study of Anxiety Disorders. In the academic year of 2010-2011, she completed her clinical internship at the South Texas Veterans Health Care System.

Permanent email: Anushka.v.pai@gmail.com

This dissertation was typed by the author.